Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LV. AUGUST, 1918. No. 2

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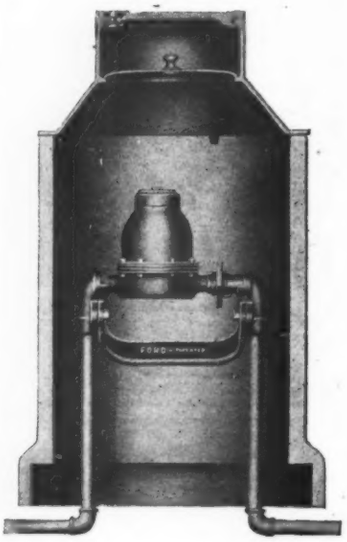

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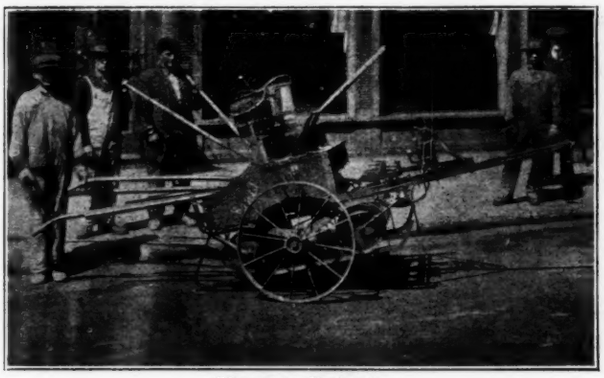

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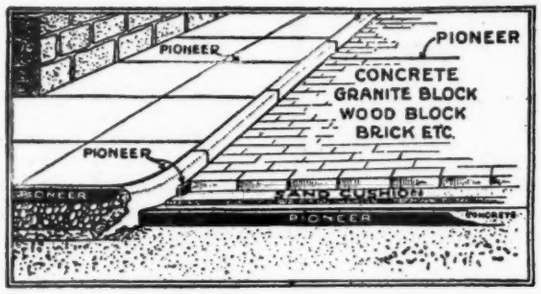

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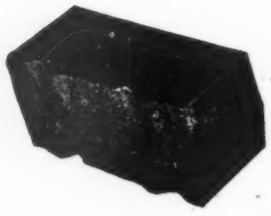

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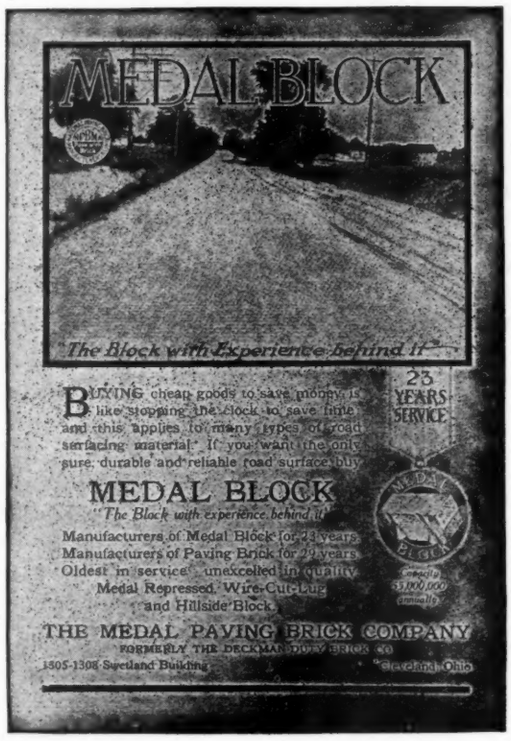
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MOTOR TRUCKS

Motor Trucks as Operated on Municipal and County Engineering Work.

(SECOND INSTALLMENT)

WILSON 2-TON DUMP TRUCK OPERATED IN CONJUNCTION WITH KEYSTONE STEAM SHOVEL ON ROAD GRADING IN WEST VIRGINIA.

Printed as insert to Municipal and County Engineering, August, 1918.

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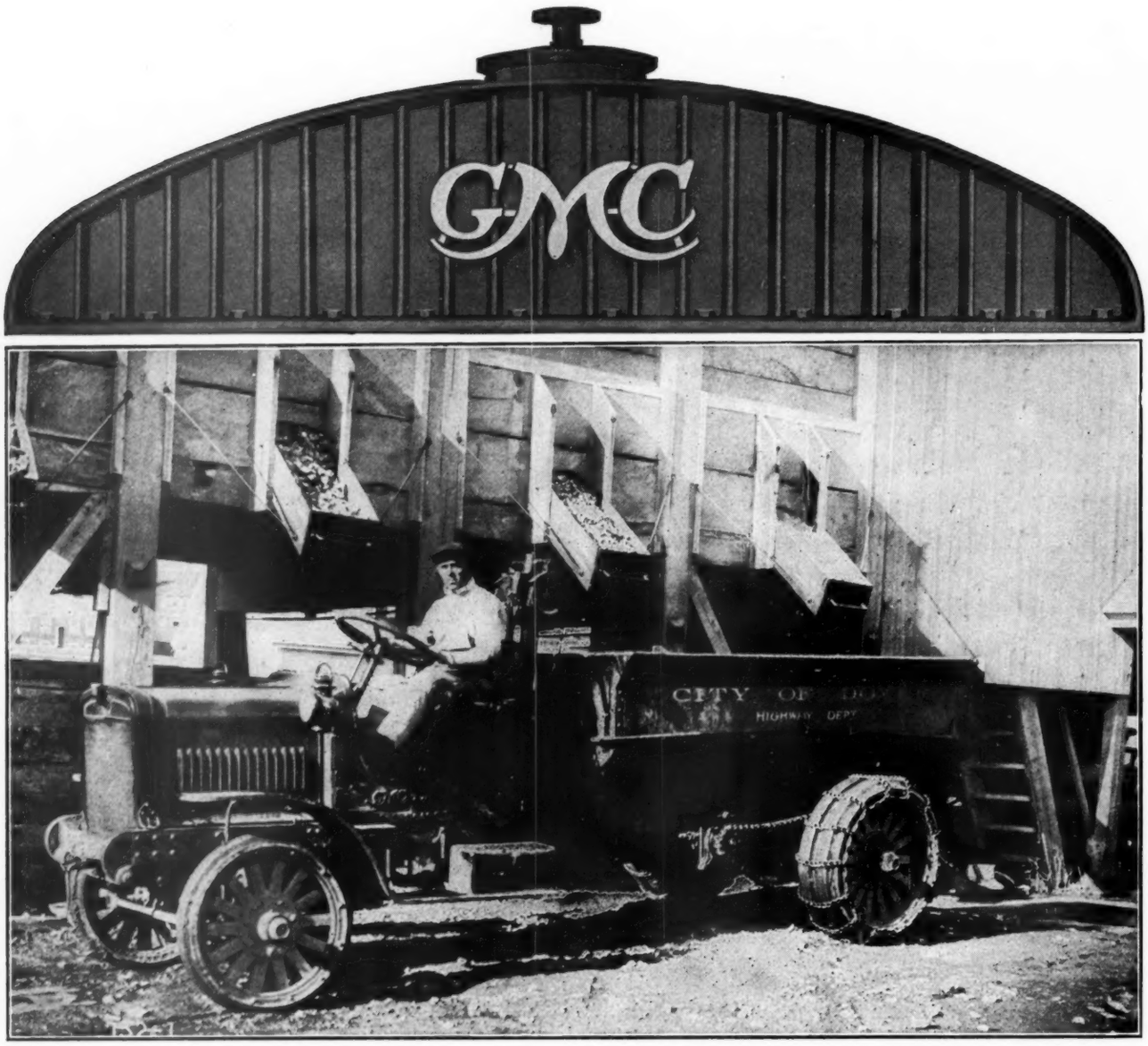

A Truck for Every Department

Municipal and county governments have come to realize the advantages of a standard motor equipment for all departments after considerable experience with a varied program of motor transportation and hauling.

It is for this reason that a number of them have already settled upon GMC as the standard for their fleets. The fact that GMC is offered in a complete line, ranging from three-quarters to five ton capacity makes it possible to standardize and at the same time have the proper sized truck for the particular job.

Especially in municipalities the need for rapid, light-weight trucks and the heavy duty trucks of big tonnage, makes standardization impossible under other conditions.

Then, too, GMC trucks have established a universal reputation for unfailing service and for a marked economy in operation and in upkeep.

The solid, perfect construction of GMC trucks makes them able to stand up under the daily grind that public work engenders, and their reserve strength insures their ability to meet emergencies without faltering.

Truck headquarters has the data on what other municipalities have accomplished with GMC trucks. This is available for your guidance.

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MOTOR TRUCK OPERATION AND ACCOUNTING XXXVI

The application of motor trucks to municipal and county engineering work, and to work of an exactly similar nature, is of almost infinite variety. Continuing the specific examples of the successful application of trucks to this class of service from the July number, the present article gives additional examples drawn from various parts of the country on a wide range of topics.

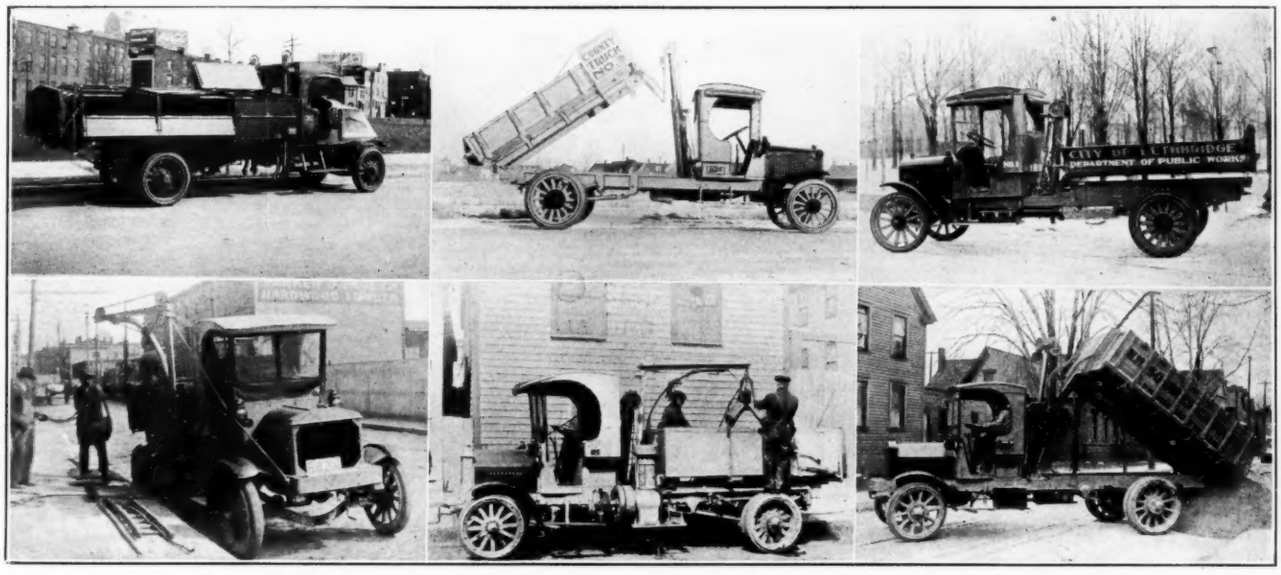
Cambridge, Mass., Equips Truck for Cleaning Sewer Catch Basins

The sewer maintenance department of the city of Cambridge, Mass., has a 3½-ton Federal chassis, equipped for excavating and transporting material found in street catch basins —mud, sand, etc.—by mechanical power, instead of human and horse power formerly employed for that purpose. The 3½-ton truck is equipped with a large steel body of a capacity of 3 cu. yds. The truck is equipped with a power dumping hoist purchased from the Boston Federal Truck Company, and the special machinery for excavating the material and loading into the truck body was made in a Cambridge machine shop from drawings made in the office of Mr. L. M. Hastings, city engineer. The general type of this equipment is somewhat similar to that made for and in use by the Public Works Department of Pawtucket, R. I. The excavating is done by a bucket of the orange-peel type, having four joints which are opened and closed by means of compressed air. In operation the bucket is dropped into the material in the basin and closed. This fills the bucket, which is then hoisted by the chain shown in the photograph, swung over to the desired position and opened, thus dropping its contents into the truck body.

Power for driving the small air compressor is obtained by a sprocket chain taken off to the left from the truck propeller shaft. Power to drive the bucket hoist is obtained by another sprocket chain taken off to the right of the same shaft. Thus it will be seen that the truck engine furnishes all the power for the entire operation of the plant air compressor, bucket hoist, dumping hoist and transportation to the dumping place. Mr. Hastings reports that the equipment seems well adapted to meet the almost continuous demands made upon it for this kind of service.

In this equipment an unusually large weight rests upon the chassis. Besides having the orange-peel bucket and steel framework and apparatus with which it is operated, together with the weight mounted on one side of the chassis, there is on the other side the compressed-air equipment, which is exceedingly heavy. There is also the hydraulic hoist for operating the steel body.

The 5-ton Federal truck owned and operated by the W. H. Squires Cartage Company, of Detroit, is illustrated herewith. This truck is used for transporting material for the extension and repair of streets in Detroit, and is of a typical type for this class of work.

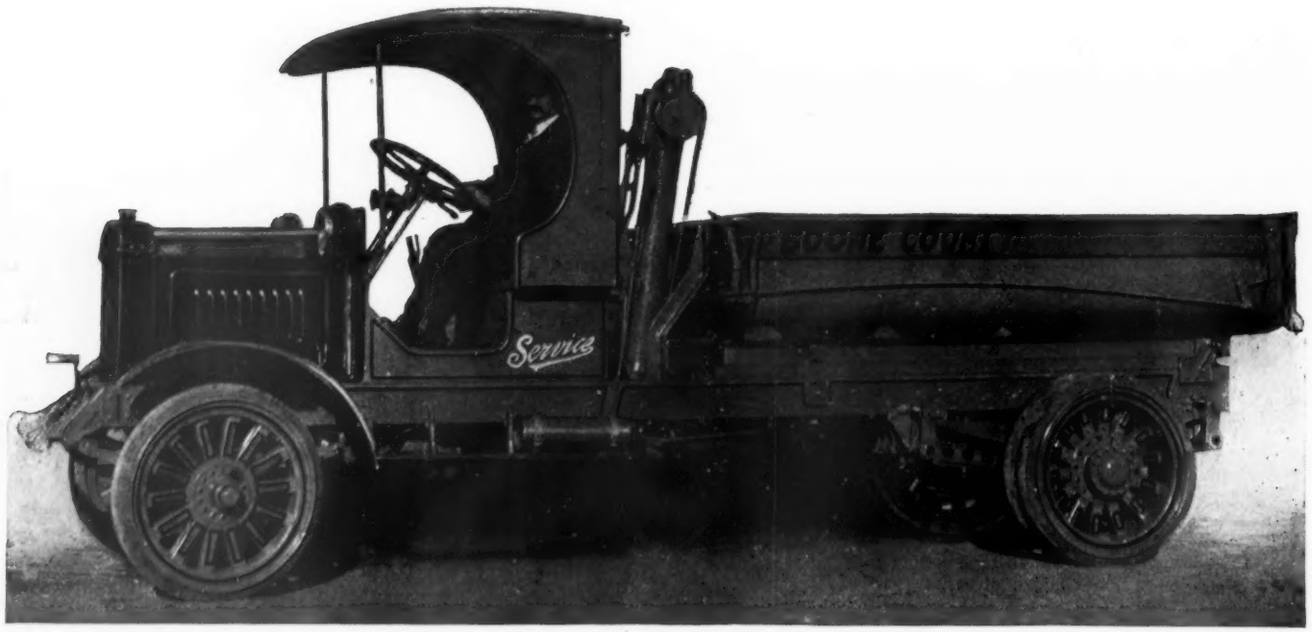


A GROUP OF MOTOR TRUCKS IN SUCCESSFUL OPERATION ON MUNICIPAL AND COUNTY ENGINEERING WORK.

Top Row: Mack 5½-ton truck with special body for hauling garbage and ashes, Philadelphia, Pa. One of fleet of five Acme trucks operated by La Porte County, Ind., on road work. This is a 3½-tonner. Acme 2-ton truck operated by Lethbridge, Alberta, in hauling garbage. Bottom row: Two views of 3½-ton Federal chassis equipped for excavating and transporting materials found in street catch basins at Cambridge, Mass. Federal 5-ton truck used for hauling material for street construction and repair work, Detroit, Mich.

Hauling Long Bridge Girders

The motor truck has solved many difficult hauling jobs involving the transportation of long lengths of heavy material. Unwieldy materials are readily transported by means of a truck and trailer; the trailer can be at any convenient distance in the rear of the truck. An interesting illustration of this class of motor haulage may be cited in the difficult piece of hauling easily handled for R. R. Sprague, of Dover, N. J., with a Garford 5-ton motor truck. This particularly unwieldy load consisted of two bridge girders 8 ft. 6 ins. long and weighing 21 tons. These girders were hauled a distance of two miles. One of the views herewith shows the load and the truck and



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DUPLEX TRUCK DRAWING SCARIFIER IN BREAKING UP OLD MACADAM ROADS IN POLK COUNTY, OREGON.

trailer wheels employed. The rear wheels, which constitute the trailer, were placed 40 ft. from the rear of the truck. These wheels weighed a ton. While the truck is of only 5 tons rated capacity, it readily hauled the two pieces like the one illustrated. In addition to the overload handled, conditions were rendered still more difficult for the truck by the fact that the freight yard where the girders were loaded was very soft and required careful planking to a depth of 6 ins. The girders were hauled without any difficulty to the bridge over the Rahway river at Cranford, N. J.

Truck Draws Macadam Road Scarifiers

A vigorous road construction campaign is being conducted in Polk county, Oregon. One of the difficult problems constantly present is introduced by worn-out macadam. In breaking up the old macadam, a scarifier is employed, and this is drawn readily by means of a Duplex 4-wheel drive truck. In this way the macadam is broken up without difficulty. The power of the truck is indicated by the fact that the 12,000-lb. safety link between the scarifier and the truck was on one day broken three times in going a distance of 200 yards. A heavier and stronger link was then introduced and two of the scarifier teeth were badly bent when operations were resumed. These teeth are 16 ins. long and 2½ ins. square. This truck is, of course, used for a wide variety of road-building operations in Polk county.

New Hampshire City Uses Truck for Variety of Purposes

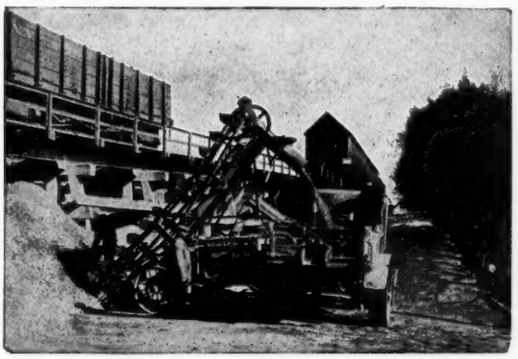
The city of Laconia, N. H., operates a 3½-ton Federal truck, bought during the season of 1917, on a variety of haulage problems. Charles A. French, city engineer, reports that the truck is found more economical than teams when used on fairly long hauls. This truck is used for hauling ashes, waste to the dump, and crushed stone, gravel, brick, pipe and coal to construction jobs. Mr. French states that the truck does the work of three or four teams in some of the hauls.

Highway Commissioner Enthusiastic About New Truck

A. J. Conover, highway commissioner, Decatur, Ill., reports the purchase and successful use on county road work of a Nash 2-ton truck. He states that he is pulling a 24-ft. Monroe leveler, with a drag hitched on behind, and in drawing this load the truck never gets "hot or tired." The truck is also used in hauling all kinds of road material, and for pulling the road oiler. Mr. Conover states that the truck will pull anything that 12 extra-good horses can draw, and will take such a load twice as far as the six teams can on a hot day. He expresses great appreciation of the help he has derived from this truck.

County Finds Trucks More Economical than Teams for Hauling Gravel on Road Construction

The motor truck has been employed to great economic advantage for hauling road-making gravel by the engineering department of Flathead county, at Kalispell, Mont. The results of this trucking were reported by Mr. F. P. Scott, of the Flathead county engineering department. Mr. Scott has compiled a table showing the cost of hauling gravel for road building by motor truck and teams. His table shows that the truck has all the best of it. When this truck was purchased it was the intention to use it on the greater part of this gravel hauling work. The truck, it should be said, is of 5 tons rated ca-



SERVICE MOTOR TRUCK OPERATED IN CONJUNCTION WITH PORTABLE BUCKET LOADER IN HAULING ROAD MATERIALS.

GARFORD 5-TON TRUCK HAULING BRIDGE GIRDER 81 FT. 6 INS. LONG, AND WEIGHING 21 TONS, A DISTANCE OF TWO MILES AT DOVER, N. J.

How the Washington County Highway Commissioners of Colorado Solved their Road Building Problems—

The necessity for conserving men and the growing scarcity of available equipment have caused municipal officials and county commissioners in charge of road-building districts to revolutionize their methods in carrying out road-building projects.

At this time, when the subject of good roads is of such national importance, and when the vital necessity of more good roads becomes apparent every day, the most efficient equipment for good road building has been receiving considerable attention.

"It has been taken for granted that in the construction of roads the tractor is ideal for possessing the unlimited power necessary to pulling road graders," says G. A. Kissel, president of the Kissel Motor Car Company, commenting on the situation. "But as tractors are badly needed for tilling the soil to help make possible the 1918 bumper crops, other sources of power are being investigated and experimented with.

"A case comes to my mind in which the County Commissioners of the Washington County Highway Department of Colorado found a way to complete their contract without taking a tractor away from its 'food-will-win-the-war' work, and at the same time discovered an added utility of the motor truck.

"With the work on the contract far behind schedule, they decided to try out a "Heavy Duty" Kissel Truck as the motive power. This truck was equipped with a steel dump and hydraulic hoist and was originally intended for the hauling of road material, but nevertheless the commissioners decided to give it a trial on the work of drawing an eight-foot road grader.

"Much to their surprise, it was found that the truck was of more than sufficient power to handle this grader easily, and with considerably more speed than a tractor. As a result, it is now being used continuously for grading purposes when not required for hauling road material.

"This use of the motor truck is being undertaken as a matter of efficiency because it is not only doing both jobs with the same power plant, but also the speed of the truck is greater than that of the tractor, and hence is accomplishing more work in less time.

"The original investment in machinery was not nearly as great, its upkeep but a fraction of what it would be if both tractors and trucks were employed.

"Moreover, as it is the usual custom of commissioners to employ a limited number of men, and as grading work and the hauling of road material is seldom required to be done in the same district simultaneously, the use of the truck for this purpose eliminates the necessity of using two expensive equipments part of the time, as the truck can be used continuously by the same crew, every day, with a big saving in depreciation and operating expense.

"I understand that since this experiment has proven so successful, other communities are considering the same plan, and under present conditions, when the tractor is needed in the agricultural districts, and men needed by the government, it certainly is worth while for county commissioners to try it out."

For further information of the adaptability of Kissel Trucks for road building and other municipal work, see nearest Kissel dealer or write direct to

KISSEL MOTOR CAR COMPANY, Hartford, Wis., U.S.A.

HALL TRUCK AS OPERATED ON HIGHWAY IMPROVEMENT WORK BY ROANE COUNTY, WEST VIRGINIA.

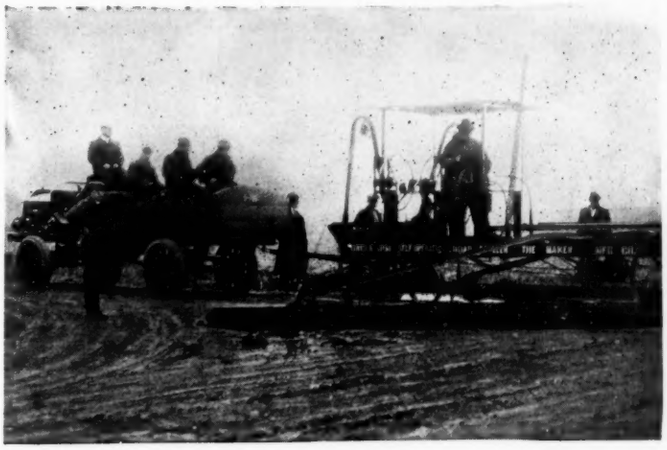
pacity, and has a body of 5 cu. yds. capacity. Because delivery was delayed, much of the spring hauling was done by team. While unfortunate from the standpoint of cost, this condition afforded an excellent opportunity to draw a comparison between the two methods of hauling. A standard report card was used to gather data from the various jobs. The card was kept by the foremen, or timekeepers, and turned in at the end of each day. The condition of the roads was such that the comparison is thought to be not only fair, but even generous to the teams.

In the cost figures given, only those items were included which were chargeable to getting the gravel to the roads. The roads had previously been graded and drained. The roadway was graveled to a width of from 12 to 14 ft., and was then spread with a grader or by hand, and rolled. In general, it was applied in one course to a depth of about 10 ins., but in some cases where the roadway was wet, two 6-in. courses were used. Incidentally, it is interesting to note that at the present time there are about 30 miles of graveled roads in Flathead county which are giving good service.

Labor and supplies were paid for at the following unit prices: Common labor, 37½c per hour; team and driver, 75c per hour; foreman, 45c per hour; truck drivers, $100 a month; gasoline, 27c per gallon; oil, 52c per gallon; coal, $8.60 per ton.

The cost table compiled indicated that there were 34,852 yard-miles of gravel hauled by the teams. The cost comparison indicates that the truck saved, where it was employed, 19.6c per yard-mile. Consequently, had all the gravel been hauled by the truck, it would have saved exactly $6,830.90. Mr. Scott considers this a strong argument in favor of the purchase of another truck.

On the team hauling, the average haul was 1.588 miles. The teams hauled 21,952½ cu. yds. The cost of team hauling per yard-mile was 43.1c. The truck hauled a total of 2,937 cu. yds.; its average haul was 2.079 miles. The cost of the truck hauling per yard-mile was 23½c. In the team-hauling figure given is included the cost of the labor, teams, depreciation and interest. In the truck-hauling figures given, the wages of the driver are included, as well as truck repairs, cost of fuel, interest and depreciation.

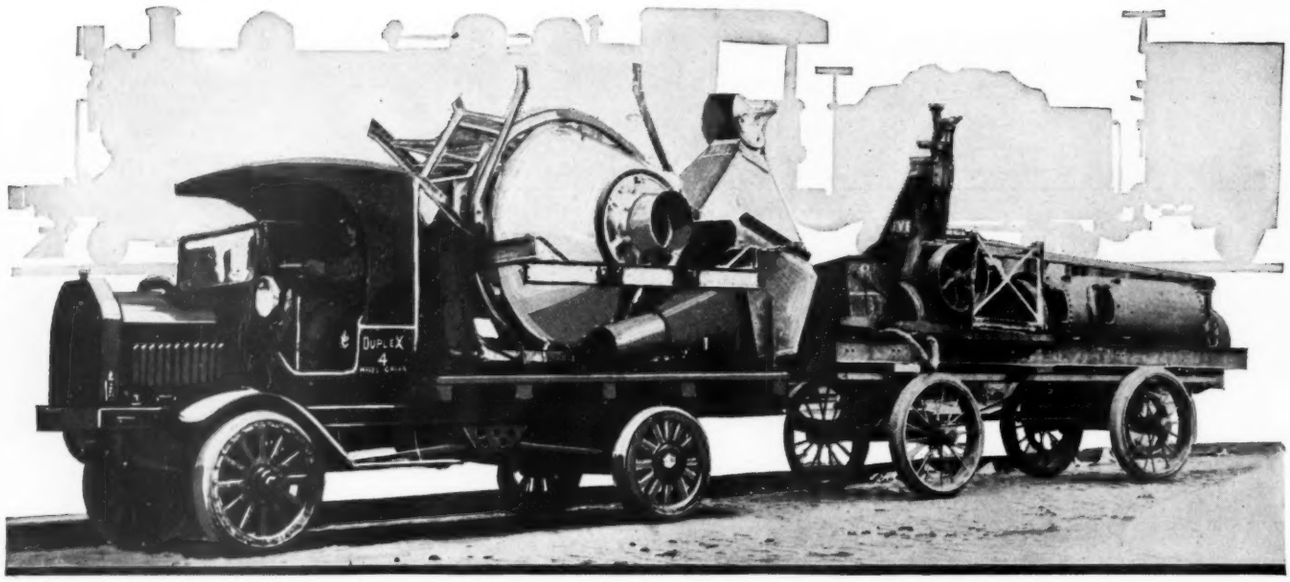


DUPLEX TRUCK HAULING "UNCLE JIM" ROAD LEVELER ON IOWA ROAD GRADING WORK.

Canadian City Indorses Use of Acme Trucks for Hauling City Garbage

Lethbridge, Alberta, is a city of 10,000 population, in the famous Medicine Hat district. Last year the city council pur-

ACME 3½-TON TRUCK, EQUIPPED WITH COMBINATION STAKE AND DUMP BODY AS OPERATED ON STATE ROAD WORK AT BELGIUM, WIS. TRUCK HAULS 33 CU. YDS. CRUSHED STONE, 4½ MILES DAILY AND DISPLACES SEVEN TEAMS AND DRIVERS.



Who Dares to Compete with the Railroads?

Van Horn, of Denver, with his 3½-ton Duplex 4-Wheel Drive Truck, dared. And he made $31.16 by so doing.

A 6-ton concrete mixer was bound from Denver to Broadmoor—a matter of eighty miles. The railroad freight rate, including teaming at each end, was $83.00.

"Let Duplex do it," said Van Horn to the Stewart Construction Co., who were paying the bill. "I'll guarantee railroad schedule delivery and a saving of 33 per cent." And the deal was made.

DUPLEX 4 WHEEL DRIVE

11th YEAR

The 6-ton load took a truck and trailer eleven hours' time. Had it not been for a hail storm further softening the gumbo roads, better time would have been possible.

The total cost of the *round trip* (160 miles) was $23.83; this included gasoline, oil, driver's salary and expenses. The haulage charge was $55.00. Van Horn's profit was $31.17. The Stewart Co. saved $28.00. The only loser was the railroad. * * * *

P.S. En route, the Duplex—in addition to its own load—hauled a tool house a distance of 185 feet in twenty minutes, after a well known rear-drive truck had been trying for two hours to make a start. (The Duplex driver collected the side bet.)

Certainty of performance is an in-built Duplex characteristic. Record-breaking haulage feats are invariably Duplex-made. Duplex principle and construction provide for such service.

Four-wheel-drive means four points to which engine energy is evenly distributed—four points at which power is geared to the road surface.

Men to whom the transportation of freight is a matter requiring serious consideration are requested to write to us for facts and figures on Duplex Trucks; we will also send "Duplex Doings"—the heavy haulers' magazine—free each month.

DUPLEX TRUCK COMPANY
2050 Washington Ave. Lansing, Mich.

DUPLEX FOUR WHEEL DRIVE TRUCK

FEDERAL MOTOR TRUCK AS OPERATED BY THE STREET DEPARTMENT, LACONIA, N. H.

chased an Acme 2-ton truck, and after an extended trial, covering both summer and winter operating conditions, the city commissioners, in January, 1918, presented a resolution to the city council, reciting the performance of the truck and recommending the purchase of a truck of this sort.

The gist of the resolution which was passed by the council on January 30, 1918, is as follows: Since it is apparent to the city commissioners that a change from carts to trucks in handling the city garbage is very desirable, and since the commissioners figure that the price, approximately, of trucks can be saved in one year by the use of the trucks, the commissioners, after considering various bids, concluded that a 2-ton Acme truck, at a cost of $4,047 f. o. b. Lethbridge, be purchased by the stores department. The resolution stated that the cost of this truck was to be met by the saving in the cost of garbage collection and should be paid by the Public Works Department.

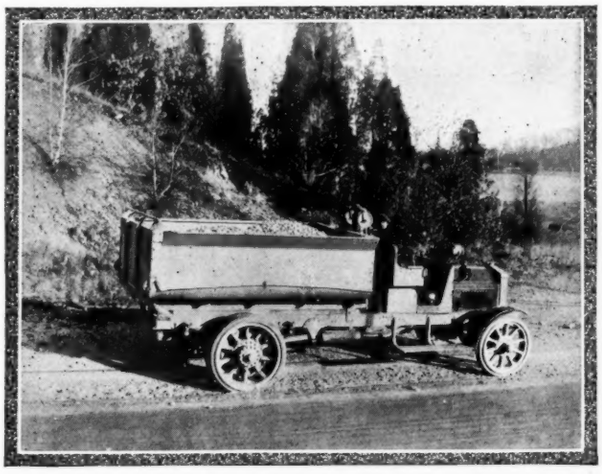
In arriving at the saving due to the use of the trucks, the following figures were presented:

Present cost for removing garbage on South Side.....$8,000

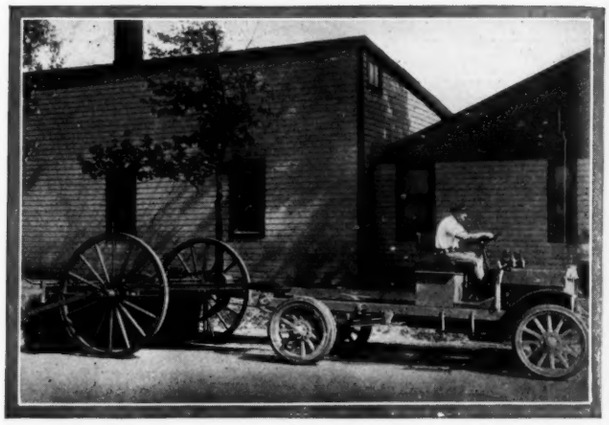
The estimated cost of operating the truck was as follows:

Maintenance, per annum	$ 500
Driver, per annum	1,000
Two laborers, per annum	2,000
Total cost of operation, per annum	$3,500

Thus it will be seen that the actual saving due to the operation of this truck is $4,500 per annum.



FEDERAL 5-TON DUMP BODY MOTOR TRUCK AS OPERATED ON ROAD CONSTRUCTION WORK BY J. H. EAGER, MILTON, MASS.



FEDERAL TRUCK DRAWING STREET SWEEPER, MONTREAL, QUEBEC.

Beaumont, Tex., Indorses Performance of Garford Motor Flusher

Beaumont, Tex., has in service a 1,500-gal. Garford motor flusher. Mr. E. J. Diffenbacher, mayor of Beaumont, reports highly satisfactory results from the use of this equipment. The truck unit operates over 65 miles of street flushing daily, and is doing the work of street cleaning in a better and more sanitary manner than it was previously done. Beaumont streets have been washed cleaner and kept in better condition since the purchase of this motor flusher than ever before. The Garford unit is especially commended in the light of Beaumont conditions, because of its close-coupled construction and its short wheel base, which permits operating to the best advantage, even in the narrowest streets. The mayor states that he considers this an economical method of street cleaning.

Wilson Truck on Road Construction

One of the views herewith shows a 2-ton Wilson dump truck in operation by a road contractor in the vicinity of Chester, W. Va. The steam shovel illustrated was used at the time the view was taken to reduce the grade of a 14 per cent. hill, and the earth removed was used to raise the grade at the foot of the hill. The truck ran down from the point where the shovel was located—a distance of about 200 yds.—and dumped the earth and then turned off the embankment so created into the bed of a dry creek and traveled up this bed to the top of the hill, where a turn was made in order to get by the shovel.

FEDERAL 3½-TON TRUCK OPERATED BY ROAD AND BUILDING DEPARTMENT, TENNESSEE COAL IRON AND RAILROAD CO., BIRMINGHAM, ALA.

Another FEDERAL

3½-Ton Federal which has replaced teams in the municipal work of Laconia, N. H.

"Return Loads Will Cut Your Costs"

"We Find the Federal Very Satisfactory!"

WRITES City Engineer, Charles A. French, of Laconia, N. H., "as we are certain, from actual experience, that Federal Trucks are more economical than teams.

"Our truck does the work of three or four teams on some of the hauls."

There is a message here for other City Engineers who may not be familiar with Federal economy, rugged strength and durability.

Write for your copy of *"Traffic News"*—a magazine for truck owners and buyers.

Federal Motor Truck Company
35 Federal St. Detroit, Mich.

FEDERAL

One to Five Ton Capacities

ONE OF THE HALL TRUCKS OPERATED ON HIGHWAY IMPROVEMENT WORK BY SALINE COUNTY, KANSAS.

The truck easily outdistanced the horse-drawn wagons which were used on the work, both in cutting down the hill, discharging the load and returning. The motor truck made approximately three round trips in the time taken by horse-drawn vehicles in making one round trip. At the point where the fill occurred, owing to the steep angle of the sides and the soft material, the horse-drawn vehicles were overturned at least on every other trip. Owing to the superior control of the motor-driven vehicle and its ability to use great power instantaneously when necessary, to overcome a capsizing inclination, it did not overturn a single time. Every load carried was one of 3½ tons, but in spite of this great overload, the truck operated satisfactorily.

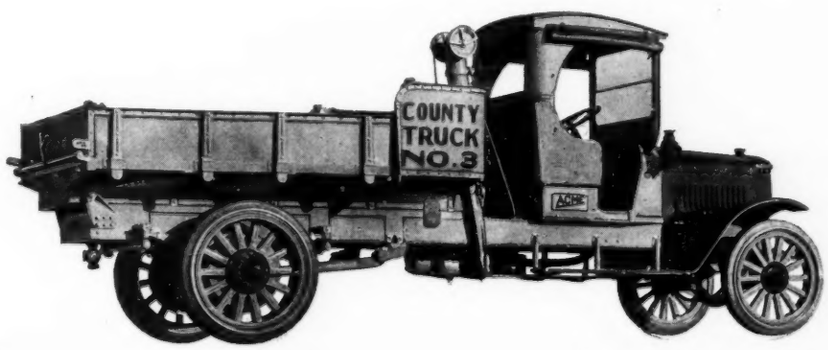
Miami Conservancy District Using Large Fleet of Heavy Duty Trucks.

The Miami conservancy district, in charge of the flood-prevention work in the Miami valley, in the vicinity of Dayton, Ohio, is handling one of the largest construction jobs in the country, and is operating a large fleet of heavy duty motor trucks in the making of this $25,000,000 improvement. The commission has purchased and placed in service the following trucks, all of Pierce-Arrow manufacture: Seven 5-ton, 4-yard steel dump trucks; seven 2-ton chassis with platform bodies, and one 5-ton long wheel base platform body machine equipped with a Mead-Morrison winch for loading heavy machinery. For handling various light jobs, including the transportation of men, nine 1-ton Fords have also been purchased.

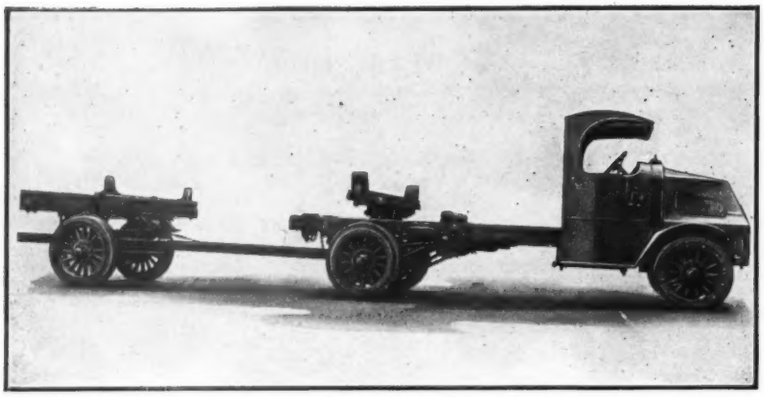
The working points in the district extend for a distance of approximately 60 miles north and south and about 15 miles east and west. The various jobs in the larger job are scattered over this territory at about 14 different points. At each of these points there is a big job. While this work has been described in the engineering press, it is probably well to state briefly that it is the result of the flood of 1913, when the Miami river and its branches flooded and caused a property damage of not less than $100,000,000 in Dayton and vicinity. The loss

GRAM-BERNSTEIN 5-TON DUMP TRUCK AS OPERATED ON PUBLIC IMPROVEMENT WORK.

of lives was also great. To forestall the repetition of this disaster the present works are being constructed. Essentially they consist of adequate retention reservoirs and of channel



ONE IN A FLEET OF FIVE ACME TRUCKS USED ON COUNTY ENGINEERING WORK BY LA PORTE COUNTY, INDIANA.

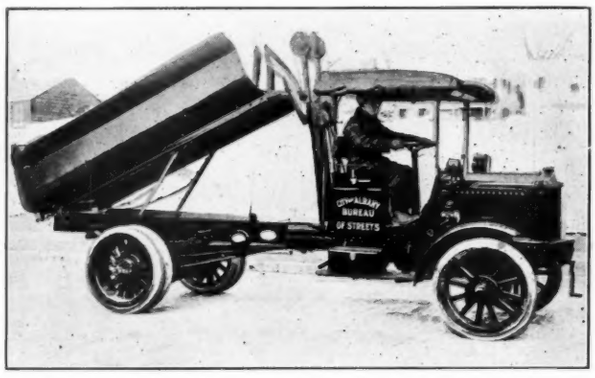


MACK 7½-TON TRUCK WITH TRAILER ADJUSTABLE FOR LONG OR SHORT LENGTHS OF LOGS OR LUMBER, AS OPERATED AT SEATTLE, WASH.

improvements in the streams. These measures, when completed, will remove the danger of disastrous floods. To carry on this work a bond issue of $25,000,000 has been authorized, and $15,000,000 in bonds has been sold. The Miami conservancy district, equipped with this money, its corps of engineers and its offices, is on the job.

The headquarters of the commission are at Dayton, and the principal material warehouse is located in that city. Adjacent to the warehouse is the machine shop, where repairs can be made and where all the machinery used in the construction will be repaired. Naturally, a good deal of the material to be used will be delivered direct to the job by rail or from near-by railway points, but much of the traffic must be handled from Dayton. At the present time there is much hauling from Dayton, as construction camps are under construction at five dam sites. Materials for these camps are being motor-trucked from Dayton, and the men who are working on the camps on the first stages of the construction work, are going back and forth to work from Dayton by means of motor trucks. While many of the points at which work is being done are on railroads, in practically every instance the steady use of trucks will be necessary while the work is in progress. Even in the city of Dayton, where the channel improvement work is extensive, it is thought that more motor trucking will be necessary than at any other point in the big job.

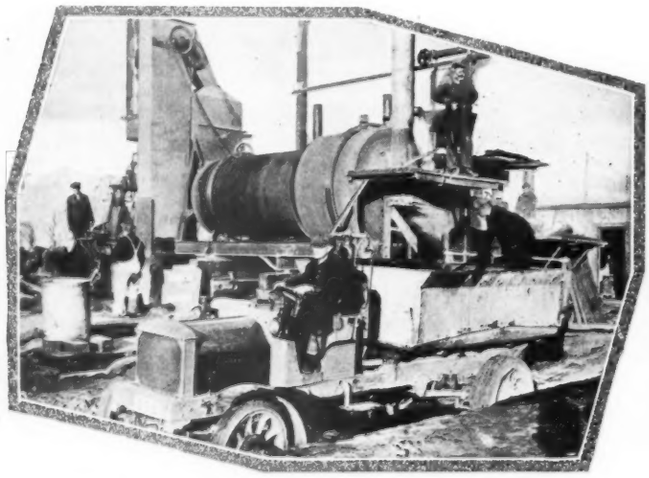
As the work progresses the hauls will become shorter, as the railroad and siding facilities will naturally be extended where carload shipments can be handled to advantage. In the case of the construction of the dam at Germantown, the site of the work is two miles from the nearest railway, so that all the building material used, as well as all fuel for the equipment, the supplies, the machinery, and everything else required, will be hauled by motor trucks. All of the food required by the 1,500 men now working on the Germantown job



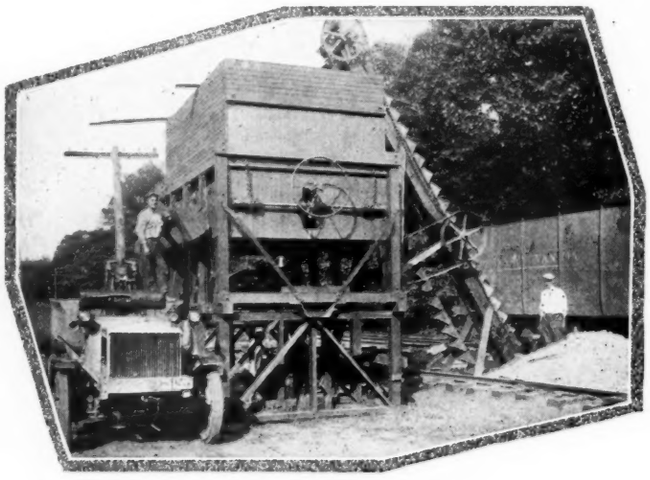
FEDERAL TRUCK USED ON STREET CONSTRUCTION AT ALBANY, N. Y.

is prepared at Taylorsville and distributed by trucks to the several camps. This will keep several light machines constantly busy.

The job of hauling broken machinery from the various points to the Dayton machine shop for repair, is extensive.



FEDERAL 5-TON TRUCK AS OPERATED ON ASPHALT ROAD CONSTRUCTION BY MANCHESTER, N. H.



FEDERAL MOTOR TRUCK AS OPERATED ON CONCRETE ROAD CONSTRUCTION, ATLANTIC CITY.

The extent of the construction plant now in service may be realized from the statement that the commission now has in service 17 drag line excavating outfits, 13 standard-gage locomotives, 80 12-cu.yd. dump cars, and a vast amount of electrical equipment, concrete mixers, industrial locomotives, etc.

The motor fleet is handled in an efficient manner by an organization under a truck dispatcher. The dispatcher is stationed at the Dayton warehouse and keeps in constant touch with the operators of the machines. It is his business to see that each truck is routed to a point where it can work to the best efficiency. He maintains communications by telephone with the vehicle stations at the various camps and construction offices. Records of truck performance are being kept.

Dump Truck Powered *with* Wisconsin Motors

CONSISTENT

The standard power for municipal trucks

Write for specifications on different types and sizes.

WISCONSIN MOTOR MFG. CO.
Station A. Dept. 330
MILWAUKEE, WIS.

New York Branch,
21 Park Row,
T. M. FENNER, Factory Rep.

To Truck Dealers

Send today for full particulars of **Schacht's** very profitable local dealers' and contracting salesmen's contract. Where we are not represented we are offering a most liberal agency contract—backed by the finest kind of truck, a splendid organization and our own complete factory.

Immediate Delivery—2, 2½, 3 and 5-ton capacities.

Write or Wire—

G. A. Schacht Motor Truck Co.
CINCINNATI, OHIO.

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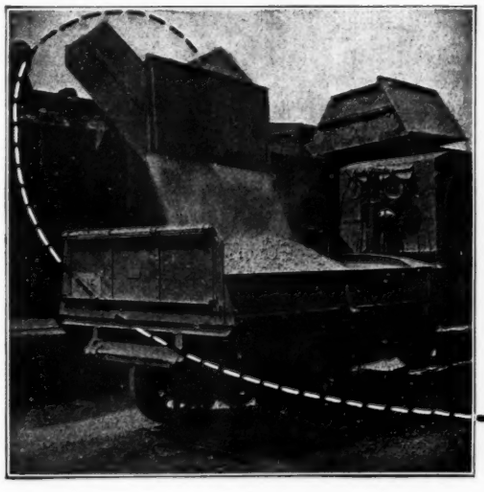


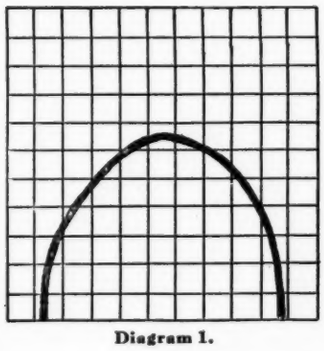


Diagram 1.

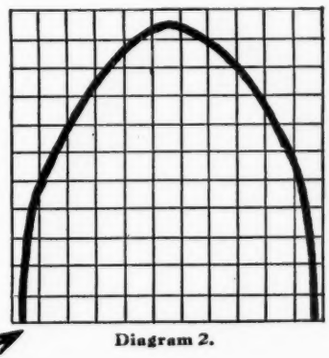


Diagram 2.

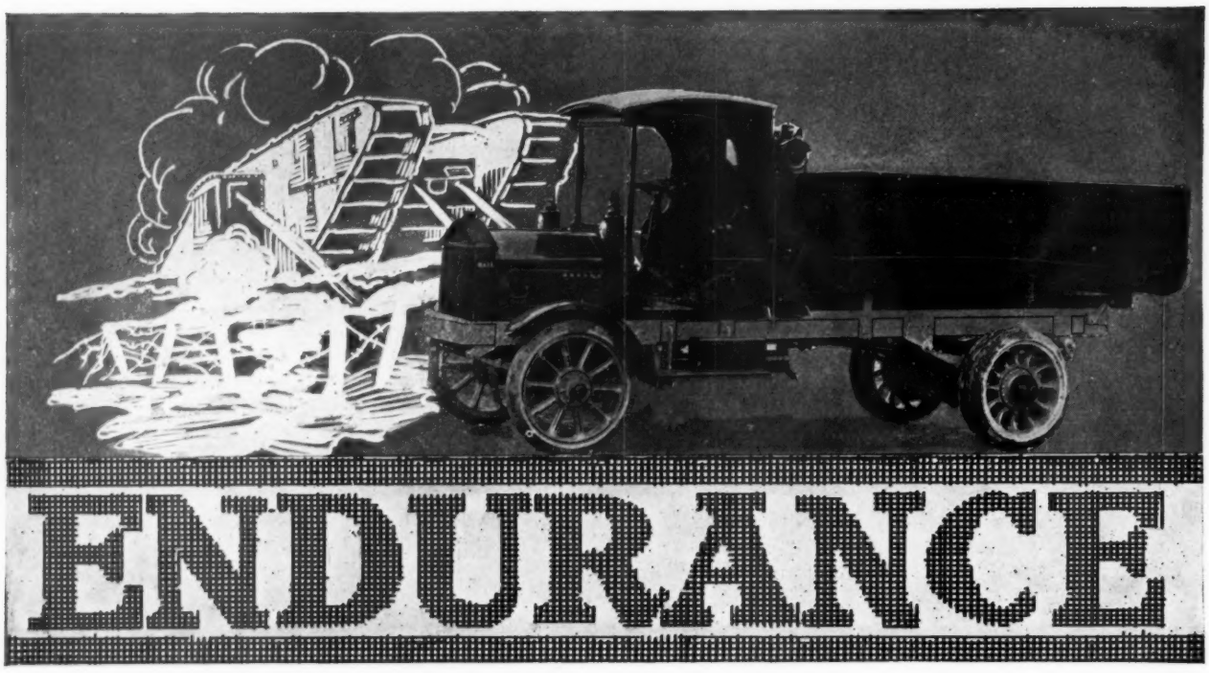
Diagram 1—shows your *present* capacity for unloading if you are not using the **Heltzel "Lightning" Loader Skip.** This *handicap* delays your trucks, delays the job, keeps the men loafing, and piles up on your account *$10.00 per day* demurrage charges!

Diagram 2—shows *three times* your capacity for unloading if you *use* the **Heltzel "Lightning" Loader Skip.** This advantage permits you to keep only a few shovelers busy *all the time,* keep the trucks actively moving and *hasten the work!*

Three times the unloading capacity—with fewer shovelers—by using the Heltzel "Lightning" Loader Skip.

Moral*—Speed up your unloading and save time and money with the Heltzel "Lightning" Loader Skip. *Read our illustrated literature.

HELTZEL STEEL FORM & IRON CO.
WARREN, OHIO.



Endurance! There-and-back travel day-in-and-day-out—without *mishap.* HALL endurance means *continuous haulage*—not a single day's loss—no serious inconvenience! HALL springs are extra wide and long—flexible—jar-absorbing and jolt-absorbing. Heavy steel frames (forged in our own shops). Continental Motors. Timken Axles and Bearings. All *standardized*—all part of HALL *Endurance.*

HALL Trucks are built to ***stand up*** in the daily grind of heavy contracting and freight haulage.

"HAUL IT IN A *HALL*"

is a money-meaning phrase for truck users.

THE LEWIS-HALL IRON WORKS

Manufacturers of the HALL Truck
(Established 1873)

Ferry Avenue and Grand Trunk Ry. **DETROIT, MICH.**

New York Distributors: R. D. King Motors Co., Inc., 9 Central Park West, New York City, Metropolitan Dealers.
New England Distributors: Hall Motor Truck Co. of N. E., 1123 Commonwealth Ave., Boston, Mass.
Guarantee Automobile Exchange, 629-31 N. Broad St., Philadelphia, Pa., Philadelphia Dealers.

EDITORIALS

How Are the Plans Progressing?

Months ago it was strongly urged that cities take advantage of the lull in construction to bring all their engineering records down to date, and to prepare plans for public improvements to be built after the close of the war, or perhaps before that time. It is known that some cities are following this program, but it is suspected that all are not doing so. Cities that are not laying careful and comprehensive plans for future construction work are slacker cities. They are remiss in their duty to their own citizens and to the nation.

After all has been said and considered, the surest thing we know is that there will be a construction boom of unprecedented proportions as soon as the war ends. All engineers, all manufacturers and all economists hold confidently to this view. The logic of events will lead to this construction era. The present rather general postponement of improvement enterprises is storing up a great volume of construction work which will be released when the war ends. All the precedents point in this direction. There can be no reasonable doubt on this point. It is inexcusable for any set of city officials to procrastinate further in planning these improvements.

Cities that do not plan now will of necessity plan hastily at the close of the war. Half-considered plans will be hurriedly executed to the permanent disadvantage of the city that did not plan in time. Now, there is ample time for careful planning, and the best talent can be secured. In the nature of things so many cities will wait for the return of peace before doing anything that the best engineering talent will then be overwhelmed with work and will be obliged to turn down many opportunities. Important planning will be entrusted, then, to relatively inexperienced engineers who will probably command higher fees than the very best engineers would ask in these times.

What we have said is predicated on the assumption that construction will boom after the war but not before that time. We have kept on the most conservative ground. But there is another reason for planning now and that is that there may be more construction before the end of the war than now seems likely. The end of the war may be far off and many cities now determined to do nothing until that time may change their programs as month after month passes without seeing the end of the war. Improvements cannot be postponed indefinitely and probably will not need to be so postponed. Cities may want plans sooner than they now think likely and may want them badly, either to provide an improvement that cannot be longer deferred or to relieve a condition of unemployment.

Unpreparedness for war has cost us much, both directly and indirectly. The folly of military unpreparedness is now generally admitted. But this is only one form of unpreparedness. There are other forms of business and industrial procrastination that are enormously costly in the long run, though lacking the dramatic interest of military affairs. To refrain from making plans now is to be unprepared for peace which is even less excusable than being unprepared for war. There was a chance, if but a slight one, that we should not have war, but there is no chance that peace will not return. Cities should prepare for peace now. The elementary, time-tried and universally approved method of preparing for peace is to have ready for launching at any time a comprehensively planned construction program.

City officials who fail to plan now cannot hope to escape the most bitter criticism when the plans are wanted. They will be held guilty of totally inexcusable shortsightedness if not of gross stupidity.

When Contractors' Bids Are Too High

The financial hazards in the contracting business, always great, are growing greater. With this increase in the money risks of the contracting business the contractors, naturally enough, are becoming more and more cautious about assuming the risks imposed by a contract. Consequently, some contractors are raising their bids to cover all known contingencies and all the others they anticipate or fear. The result of this method of price fixing is that many bids are being rejected because too high. In some cases officials feel that the bids are disproportionately high, even considering all the uncertainties now surrounding the carrying on of construction work. What is the remedy for this condition of affairs? First, readvertise for bids and if they are still too high, perform the work by day labor where this can legally be done and where the improvement is considered essential.

A situation of this sort in Illinois has attracted attention and serves well as an illustration. Bids were submitted for the construction of certain sections of the Dixie and Lincoln Highways, as a part of the Federal Aid System, for which funds are available, but were rejected because they were too high. There were no bidders on a number of sections and on several other sections the bids appeared excessive, to the state officials, even under existing conditions.

In rejecting the bids a statement to county boards and highway officials was given out by officials of the State Department of Public Works and Buildings, in which contractors were absolved from blame for the high bids. The portion of the statement bearing directly on this point was as follows:

"Because of the uncertainties of the situation brought about by war conditions no blame can be attached to contractors. Contractors are obliged to take into consideration many things over which they have no control, among which are the following: The liability of a wide variation in the cost of labor; possible difficulty of obtaining labor at any price; impossibility of determining the cost of materials; difficulties likely to be encountered in transportation because of shortage of cars; and, possibility of further advance in freight rates."

The department, at the time of writing, is making an investigation in conjunction with the Federal authorities to determine whether these Federal aid roads should be considered of sufficient importance for the movement of fuel, crops, munitions and other war

materials to warrant their construction by the state itself.

Certainly the state should take up this work. The improvement of the sections in question would give a good road usable every day in the year throughout the entire length of the Dixie and Lincoln Highways in Illinois. These improved roads would be of great economic value as an aid to transportation, inasmuch as they would connect important centers of production of both agricultural and manufactured products.

In building up organizations for emergency construction work by day labor, in circumstances similar to the foregoing, existing construction organizations might well be utilized. In this case no question was raised as to the ability of the contractors to carry on the work successfully; the only question was one of price. As the price was too high because of risks an individual dared not assume, why not let the state assume the risk and let the contractors' organizations carry on the work? This does not mean a cost plus contract, necessarily. The organizations should be drafted by the state, if the contractors agree to this course, and should work under their own foremen and superintendents. The contractors themselves might well be engaged, at adequate salaries, to assume general control of construction operations.

By following this course the state will promptly secure the roads it needs most and will get them at a minimum cost; construction organizations, which are a great economic asset to the state, will be preserved intact, and individual contractors will be safeguarded against financial ruin, while enjoying useful employment. This may not be a 100 percent winning combination, but has anybody a better suggestion?

Government Boards Should Differentiate Carefully Between Country Roads and City Streets

The engineer of pavements of a great city has called our attention to the seeming lack of experienced street paving engineers among the advisors of the Federal Government on highway matters. It seems that the highway departments of the various states are the local agencies through which the government control of paving is exercised. Most of these departments are new, and while not necessarily inexperienced in road work are, as a rule, unfamiliar with street paving and urban work.

Our correspondent suggests that the Highways Council have properly qualified local representatives in all states or large cities, familiar with city paving problems and willing to report as to the economic merits of any projected improvement. This would be far better than to compel interested parties to spend considerable time and money in visiting Washington so frequently.

Federal agencies, with authority in the premises, have in some cases shown a disposition to halt construction operations under way on a system of street paving because of an alleged shortage of asphalt or asphalt oil. Seemingly the difference between interrupting construction operations on a country road and a system of city streets was not properly appreciated.

On the system in question the proceedings were initiated four years ago, but were delayed on account of reconstructing the sewer system. Now the sewer system has been completed. The contract for paving the system was awarded early in April of this year. The work has proceeded to the extent that practically all the curb is in place. Ninety percent of the grading is completed and all the sewer adjustment work is finished. Were the streets left in their present condition they would soon become dangerous, impassable and a menace to health. The subgrade is clay, and with the sewer inlets adjusted to fit the surface of the finished pavement the streets would not be drained but would soon become an unsanitary quagmire. This is special assessment work and to leave it partly completed would undoubtedly introduce legal complications. Yet there is danger that the work will be delayed or its completion interfered with in part.

In this case the specifications are very economical of material. On the 6-in. concrete base is to be placed a 1-in. binder course and a 1½-in. top wearing surface. The amount of pure asphalt in the top and binder courses is only about 5 percent of the 2½-in. asphalt top. The cost of the asphalt is only 1 percent of the cost of the entire improvement. Now, with the situation as described, it is reported that but 60 percent of the work can be finished! Such a rule may be applied in the case of a country road of single length, but cannot be applied in fairness, or to any satisfactory degree, where a complete inter-related system of streets is being improved.

One Extreme Almost as Bad as the Other

"Business as Usual," long since demonstrated its unfitness as the slogan of a great nation at war. Under modern conditions, business cannot be the same in war times as in peace times. That truth is now generally understood and admitted. But there is great danger now that we shall go too far in the opposite direction; that all business will be despised unless it is war business. Such a policy if too long pursued will result fatally to numberless important private business enterprises, not only, but will jeopardize the chief business of the nation—the winning of the war.

The war should be viewed, rationally, as a great industrial enterprise, as the nation's greatest business undertaking, but not as the only necessary and legitimate business of the country. The war in its employment of millions of people, in its concentration of billions of dollars in capital for a specific purpose, in its utilization of machinery and materials for the purposes of production and destruction, is a gigantic industrial enterprise. Like any other industrial enterprise it is dependent for its ultimate success on the proper functioning of general business processes. These thoughts are expressed not through any lack of appreciation of the sacrifices that are being made, and must continue to be made, not from any narrow view of the objects of this most righteous war, but to draw attention to the fact that the war is, after all, not the only business of the country. We trust official Washington can soon devote more thought to this aspect of national affairs.

Being so thoroughly unprepared for war as we were, an economic convulsion had to be endured while the war industry was being organized and getting itself placed among the other industries of the country. There are some signs, however, that the process of adjustment is nearing completion. Perhaps by another year, if the war is still in progress, it will be somewhat more of an industrial side issue and not quite so much the whole business show. This condition has now obtained in Canada for many months. Mars is yet, in a sense, sitting on the Canadian neck, but he is sitting still. That is a relatively desirable condition to which American business can look forward.

PAVEMENT DESIGN AND CONSTRUCTION

How to Get the Best Surface on a Concrete Road

By A. H. Hunter, District Engineer, Illinois Department of Public Works and Buildings, 302 Apollo Theater Bldg., Peoria, Ill.

In spite of the excellent riding qualities of pneumatic tires, together with all the experience and skill incorporated in the design of body, springs and wheel base of our automobiles, the automobile public is demanding improvement in the surface conditions of our concrete pavements. I do not feel that this is because previously constructed pavements were so decidedly inferior, but rather that with the coming of long stretches of improved surface, the novelty of riding on concrete diminishes. The traveler traversing longer units than before becomes more weary, and with the accompanying fatigue comes criticism of surface imperfections hitherto unnoticed, said Mr. Hunter, in addressing the American Concrete Institute at Atlantic City, N. J., on June 24.

Any road surface, however durable, can scarcely hope to be ultimately successful for use in our through highways unless this wearing surface presents a minimum of jar and vibration. In a properly mixed concrete, such as is used in concrete road work, we have a plastic material susceptible of being molded into a nearly perfect surface. How closely we are to approach this theoretical plane surface depends upon the care and effort put forth by the workman in finishing. Upon workmanship depends largely the riding quality of surface secured.

The impression is not to be gained, however, that proper design is not essential. It would be utter folly to neglect drainage, crown, or both horizontal and vertical alignment, but fortunately practice is becoming so standardized that most highway engineers recognize these important features in design. It is most infrequent to find a concrete pavement on which poor riding qualities may be attributed to poor engineering.

If we are to avert a repetition of past errors, certain construction features must be carefully watched. These features are to be considered from their significance as outlined in the specifications as well as their application by the layman.

Forms Must Be Rigid

Too often the layman looks upon the side forms as merely a necessary convenience for holding the concrete, thus losing sight of the fact that the proper grade and alignment of these forms are highly essential if a smooth surface is to result. Not infrequently I have visited construction work and found adjacent form boards out of both grade and line. It is probable that in so far as line is concerned, the earth shoulder will later absorb a fair amount of irregularities, but it generally follows that a form setter who does not take enough pride in his work to align the boards properly is equally careless in setting the edge to the proper grade.

In early concrete pavements, wood forms were used exclusively. These, when properly used and well taken care of, have given excellent results. When in the hands of careless workmen they soon warp, spilt, and, when not properly cleaned, cause frequent damage to the edge of the green pavement. When placed to accurate grade and alignment they must be thoroughly staked. Using too few stakes is fatal. If these forms are not rigid, waves, bump and depressions inevitably occur in the completed surface.

Once I heard criticism of the large vibratory finishing machines from the standpoint that they impose a larger load upon side forms than was thought advisable. Personally, I do not take it as a criticism of the machine, but rather of the forms. Make them rigid, and the template, properly used, will cut the surface to the desired shape.

Steel forms are coming into general use. It is probable that specifications in the near future will express a decided preference for them. Many contractors, in an effort to save, purchase too light a weight, with the result that they are soon bent, twisted and unfit for use. In spite of preference for steel forms, they are not to be recommended for short, vertical curves or transverse curves of any character. They are too rigid to adapt themselves to the smooth outline necessary in a properly staked curve.

If we are to improve the surface of our concrete roads appreciably, it becomes necessary for the engineer to see that forms are accurately set to grade and alignment and maintained there. They are the only framework possible in a road. They are as essential as the formwork of a building. They are the guide lines of the pavement.

Templates Need Constant Watching

After the concrete is placed within the forms, it should be struck off with a template having a length slightly greater than the width of the pavement. An excess length of possibly 18 ins. will suffice for average highway work on pavement 15 to 18 ft. in width. This template should be moved by a combined longitudinal and crosswise motion.

Do not make the common error of cutting the arc of the template to the same dimensions as indicated on the cross-section. It should be cut ¼ in. to ⅜ in. deeper than the theoretical crown; otherwise the resulting surface will be flat. This correction should vary to correspond with the width of the pavement as well as general conditions surrounding the job. The amount of water generally employed is a factor, for it is apparent that soft, mushy concrete will flatten out more readily than that containing a lesser amount of water. This template should be shod with a steel edge, using countersunk screws.

Templates may be made from either one or two boards. If two boards are used, they are held apart some distance by small struts. This style insures a more uniform bearing on the forms, but is usually heavy, hard to handle and has a tendency to leave bumps or depressions, as the workmen are reluctant to move it back and restrike the surface.

The writer has seen good results obtained by using a heavy double-edged steel template drawn by a cable, operated by a drum connected with the engine of the mixer. There is a general tendency to supplant man power wherever possible.

In moving the template along the forms, a slight excess of material must be in advance of the cutting edge at all times. Failure to do this will result in depressions or holes. Do not permit the template to ride on stone or gravel on top of side forms. In working on grades even as low as 3 per cent., repeated striking must be done if a smooth surface is to result. The concrete, being plastic and of more or less non-uniform water content, will flow down the grade. This flow is not uniform, but is given to taking the form of alternate humps and depressions, which can only be prevented by repeated and continued striking until initial set takes place. Keeping the amount of water in the mix as low as possible assists materially.

Satisfactory results are obtainable only after pains are taken. The men operating the striker must have an interest in their work or surface defects will occur. Watch the template. Check it up every few days, making sure that it has not warped or gone out of shape.

This matter of crown of pavement was forcefully impressed upon me several years ago, in connection with the construction of my first concrete road. The template used was composed of two striking edges, several inches apart, covered with a plain board on top. At night, after work, it was washed off and placed on the forms behind the mixer. This afforded the night watchman (who, unfortunately for us, was of liberal proportions), or his visitors, a convenient seat. Continued use for this purpose resulted in a reduction in the crown of pavement by approximately ¾ in. This is no large amount, but it is apparent on pavement designed with a minimum of curvature. Frequently, too, a template, properly designed and cut to the required arc, develops a sag, due to its own weight, when placed in position on the forms. In general, templates—home-made devices especially—are not to be trusted. Good surfaces may be obtained, but it is only by exercising care and judgment that satisfaction is secured.

Expansion Joints

In the first concrete road construction expansion joints were used in varying designs. Many otherwise good pavements had their riding qualities much impaired by these poorly placed joints. Unfortunately, highway engineers have not yet agreed among themselves as to what device is best suited to serve the purpose. Until standard practice develops some uniformity, we must expect to have continued experiments, with occasional pieces of pavements unsatisfactory.

Generally speaking, any joint or holding device which does not permit the free use of the template is to be condemned. Not that excellent surfaces cannot be secured, but rather that it necessitates special care for the finisher. The elimination of expansion joints altogether, or possible acceptance of blind joints, will do much to improve the riding qualities of our concrete surface.

Finishing Surfaces as Recently Developed

Naturally enough, concrete pavements were first finished with the same tools as sidewalks or building floors. The public approval of a wood float surface led to the general use of a small wood float, 12 to 18 ins. long, operated by hand. It was possible for the contractor, at small cost, to finish by hand in a most satisfactory manner. It was a tiresome job for the finisher, operating from a cross-plank or bridge. Too frequently the work was intrusted to unskilled men, who probably slighted much of the surface, at the same time probably working holes, depressions or flat places at the more accessible portions of the surface. Many excellent surfaces have been obtained in this manner, but substitution of unskilled labor by the contractor in an effort to effect a small saving, together with the drudgery involved, led to the development of easier and better methods.

Following the hand float came the easier, but unquestionably poorer, experiment of placing a small wood float at the end of a long handle. This being operated from sides of the road, permitted the omission of a bridge. It was applicable to narrow pavements, being used with some success on roads up to 12 ft. in width. In general the surface secured was much inferior to the hand method. The central portions of the pavement were neglected, with the result that too frequent evidence of laitance, dirt or surface defects occurred near the center.

Engineers had recognized the importance of keeping the quantity of water required in the mix to a minimum, but under working conditions a small excess had been permitted, for the reason that concrete of proper consistency was difficult to work. Incidentally, the mixer with spout delivery required an excess of water. Several years ago experimenters in the states of Oregon and Michigan perfected mechanical devices for striking, compacting and finishing concrete, but these, while possessing merit, were heavy, costly and unsuited to operation on short, isolated sections.

It is only recently—not farther back than the construction season of 1916—that two simple operations, developed in different parts of this country, have been brought forward, and, when combined, resulted in radical changes in specifications and methods of finishing. I refer to the combined use of roller and belt in finishing concrete surfaces.

To an engineer of Macon, Ga., we are indebted for promoting the use of a small hand roller, some 8 ins. in diameter and about 6 ft. long. This was operated transversely across the pavement by a handle. The old adage that "necessity is the mother of invention" certainly holds true in the method developed for smoothing concrete surfaces. It is told that a contractor in Michigan, during the summer of 1916, was inconvenienced by a strike which occurred among his gang after considerable concrete had been placed, struck off, but not finished. It seems that in desperation he ripped strips of canvas from his tent, dragged them over the surface in a desperate attempt to place the concrete in a condition satisfactory to the engineer and prevent possible loss. The results were astonishing, so much so that hand finishing was afterwards dispensed with and a canvas belt substituted.

During the construction season of 1917 the engineering organization of the state of Illinois, Department of Public Works and Buildings, Division of Highways, used their influence with contractors and secured their co-operation in experiments sufficient to warrant the department in incorporating this belt-roller finish in the specifications for concrete highways, edition of March, 1918. These specifications, representing the consensus of opinion of the entire engineering organization, are based upon experience gained throughout the state of Illinois, with different aggregate, different workmen and varying general conditions encountered in actual practice.

How to Use the Roller and Belt

The entire operation of finishing is specified to consist of three beltings and two rollings, beginning with a belting and alternating until the final belting. The belts are of a canvas or rubber composition, about 2 ft. longer than the width of the pavement. This belt also should be fairly heavy, but pliable enough to conform to the crown of the pavement. No irregularities should be permitted in the edges, for these will cause ridges or depressions in the plastic surface. In both the first and second belting, the operation should consist of long, transverse strokes combined with a relatively slow, longitudinal movement. After the second rolling, the concrete is to be given a final finish, just previous to the initial set of the concrete. The time interval between placing the concrete to final finish is variable, depending somewhat upon the amount of water in the mix, but largely on weather conditions. In other words, a highly satisfactory surface can be secured by final belting when the film of surface water has just disappeared. In the last operation a light canvas belt about 6 to 8 ins. in width, used with short, transverse strokes, but with a sweeping longitudinal motion, will produce a uniformly gritty surface.

A satisfactory roller may be made with diameter of 8 to 12 ins. and a length of 4 to 6 ft., having a total weight of ¾ lb. to 1 lb .per linear inch of roller. For roads up to 15 ft. in width it may be operated by a long, light handle. Pavement of greater width requires the use of ropes in place of the handle, operated by a man on either side of the pavement. The first belting follows immediately after the strike board, and is in turn followed by the roller. The roller is thus advanced along the length of the road, each unit of surface re-

ceiving four separate treatments. A trip over in the manner described constitutes a rolling.

The surface should again be belted, and, after a lapse of 15 to 20 minutes, again rolled. This time limit must be somewhat variable and left to the option of the resident engineer. Very wet mixing or cool weather encountered may make it desirable to recommend an additional rolling before final belting. In explanation of the foregoing ideas incorporated in specifications, a word of caution in regard to belting is necessary. The first belting is done to smooth up the surface only, remove slight irregularities and facilitate the removal of the surface water in advance of the roller.

In general, belting should be a minimum, for continued working of the surface results in an excess of mortar. Present practice favors the wear coming upon the large aggregate, with only enough mortar present to bond the stones securely and prevent voids.

Possibly the foregoing description of finishing may seem complicated, but in reality the physical labor involved is relatively small—much less than required in the old wooden float method. The cost per unit of surface is materially reduced. Surface imperfections are a minimum. The roller eliminates many bumps, by pushing them into the depressions or placing them parallel to the line of traffic, where they are unnoticed. Each unit of area receives the same amount of attention, and in the end a uniformly gritty surface is obtained, far surpassing in texture, uniformity and riding qualities the original hand methods.

Roads constructed by roller method have shown an apparent reduction in the transverse cracks. Later uncompleted experiments in laboratory tests reveal the fact that with the rolling and removal of water comes an increase in concrete strength.

In mentioning the recent developments of surface finishing it should not be assumed that the roller-belt method represents conditions that cannot be improved upon. For simplicity and low cost of operation it is at present unequaled and its use is to be recommended in the construction of small, widely separated sections of work. It appears probable that future developments in concrete pavements will have largely in mind the proportioning of aggregate so as to produce the greatest possible strength. In connection there will come equipment which by rolling, tamping or otherwise will increase the density and strength, at the same time securing all the advantages of a roller-belt finish.

Maintaining Sand-Clay Roads in North Carolina

Everybody who has driven over an earth road knows that some well-drained sections are likely to be much better than others equally well-drained, but the reason for this is rarely understood. In most cases the good road is due to the fact that the sand and clay forming the surface are mixed in proportions which will give the most dense combination. There is just enough clay to bind the sand together. Hundreds of miles of good roads are now being built, duplicating artificial roads. The mixing of the sand and clay is carried on by well-developed methods and gives a good road for light traffic.

There have been many miles of these roads built in North Carolina and during the last winter a good many of them went to pieces. There was a tendency to attribute this to a failure of the type of construction, but an investigation made by Dr. Joseph Hyde Pratt, Secretary of the North Carolina Highway Commission, indicates that the trouble was due to the imperfect maintenance of the roads, which were so weak in consequence that the severe conditions of the winter inevitably damaged them, as they would have damaged any other type of construction which had been neglected until it was ready to go to pieces. Dr. Pratt insists that a sand-clay road can be maintained in good condition for any traffic for which the type is fitted, by an intelligent use of the road drag. The purpose of dragging such a road is not to bring new material up on it but to smooth out the ruts and holes by shaving material from the high places into them and rubbing it into a dense condition there. If this is done after every heavy rain a well-built sand-clay road can generally be maintained in excellent condition. It is important, however, not to scrape material from the side ditches over the roadway, because this material is not fitted for filling depressions. It usually has unsatisfactory proportions of sand and clay and often contains so much organic matter that it is incapable of becoming consolidated into a hard surface.

Where a road has become badly rutted and filled with holes, so that dragging will not remedy the neglected surface conditions, Dr. Pratt recommends reshaping the road with a road machine and then dragging it thoroughly after the first rain. If it is necessary to add new material on the surface, great care should be taken that it contains the sand and clay in the right proportions for the work, and, if possible, is the same material used in the original construction of the highway in general. Dr. Pratt believes that the sand-clay road, if it has been surfaced with the right kind of material, has been constructed properly and maintained efficiently, will prove a good highway, even under as severe conditions as those existing in North Carolina last winter. But this type of construction must be well maintained, and unfortunately there has been a lack of good maintenance throughout the state, particularly noticeable where the traffic has considerably increased since the roads were built.

Procedure in the Construction and Maintenance of Kentucky Rock Asphalt Roads

By S. O. Le Sueur, Paul Jones Bldg., Louisville, Ky.

One of the most serious problems that confronted the government at the beginning of the war was that of transportation; the problem is still serious. Various government committees have been advocating the use of the highways by motor trucks, with the object in view of relieving the railroad congestion. While good progress has been made along this line, it is far from satisfactory, and the reason for this is the condition of the highways. Motor trucks cannot operate to best advantage on roads that have even one short "weak link," consequently the improvement of the highways is essential today. Macadam, or cheap roads of similar construction, will not stand up under the heavy motor traffic to which they are being subjected. Roads of a more permanent nature must be constructed, or old roads must be surfaced with a hard type of material. Expensive types of construction are prohibitive in some counties and small cities on account of the first cost.

A permanent road of low first and upkeep cost can be laid with Kentucky rock asphalt. It is laid cold upon a base prepared as for macadam construction, with the exception that the screening course on this base is left off. The object in leaving off the screening course is to enable the material to work down in the voids and create a bond. This makes the road waterproof.

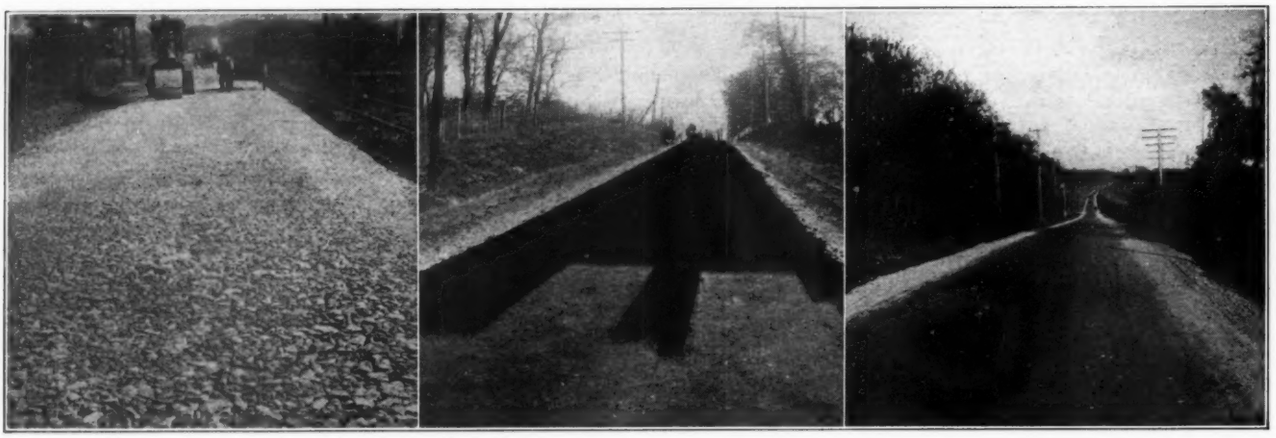
In resurfacing old construction the road should be scarified and only a sufficient amount of new stone added to give an anchorage. The stone should be from 2 to 3 ins. in size.

One ton of this rock asphalt will cover 18 sq. yds. of roadway in small towns or on county roads. For city streets and roads that are subjected to heavy traffic one ton to each 15 sq. yds. should be used. The material should be spread over the base, raked, and rolled cold. The road should be rolled once daily for three consecutive days, and is then ready for traffic, A roller of at least 10 tons in weight should be used, or one that has as much as 200 lbs. compression per lineal inch in

width. The completed road strongly resembles sheet asphalt, except that it is darker in color. There is no glare reflected from the surface.

The maintenance feature of roads of this type is one that appeals to road builders, since any defective place can be repaired in a few moments without interruption to traffic. This can be done by inexperienced men. The defective place is cut out a little, fresh material added, tamped with a hand tamper, and within two or three days it will be impossible to locate the spot where the repair was made. One man, with a suitable vehicle in which to carry a small quantity of the material, a pick, shovel and hand tamper, can maintain many miles of road at very little cost.

Kentucky rock asphalt has been used quite extensively in most of the central states. Kentucky has many miles of this



VIEWS OF KENTUCKY ROCK ASPHALT ROADS.

Base Course; Note Absence of Screenings—Asphalt Raked Over Base Course and Ready for Cold Rolling—The Completed Road in Service.

construction. Fayette county, in that state, has some 12 miles surfaced with it, and the Dixie Highway leading south from Louisville has a section of 7 miles in length that was surfaced with it over a period of 6 years. This road probably carries the heaviest volume of traffic in the state. At present, and for the past several months, it has been subjected to abnormal traffic, since the United States artillery range, located at West Point, Ky., uses it exclusively for all traffic between that point and Louisville. The road shows no evidence whatever of wear, although some of it has been laid for over six years. Approximately 4,000 vehicles per day use it.

This road and the roads in Fayette county, above mentioned, are considered by many road authorities as among the best roads in Kentucky.

The Action of Water on the Road Subgrade and Its Relation to Road Drainage

By J. L. Harrison, Highway Engineer, Road Management Division, Office of Public Roads and Rural Engineering, Washington, D. C.

The simple rising of the water table often causes highway troubles. "Keep the subgrade dry" is an old-time admonition, which was frankly based on the assumption that a good highway surface would "shed water like a roof." The dry subgrade is as much to be desired as ever, but no matter how well the "roof" acts, the subgrade will not remain dry unless water can be kept from rising into it from below.

Herein lies much of the trouble which highway engineers experience in preserving smooth pavement surfaces during the spring months. At this season more moisture is supplied than evaporates or is carried off in the ground-water drifts. As a result the water table often rises to such an extent that in low areas lakes are formed, and if a highway chances to be built over an area where this rise in the water table has brought the pavement foundation into the region of complete saturation, a marked lessening of the supporting power of the foundation necessarily results.

Limitations of Tile Drainage

Tile drainage is the usually accepted remedy for this condition of affairs, but tile drains have, very generally, proved to be of less usefulness than had been expected. One reason for this is that the water table does not have to rise into the foundation of a road to make it the source of trouble. All that is necessary is that it rise enough so that capillary attraction can keep the foundation wet. Just how near to the surface this may be has not yet been determined, but as extensive studies of the effect of capillary attraction in raising the water needed to support plant life show that capillary attraction will raise water through some soils as much as 6 ft. or more, the problem of escaping the results of capillary attraction at once appears to be a serious one. And herein lies the trouble with many of the systems of tile drainage which have been installed.

Tile drains lower the water table—that is, the level of complete saturation—but they do not affect the action of capillary attraction. As such drains are seldom placed more than 3 or 4 ft. below the surface, they do not at all prevent the wetting of the subgrade, for, in almost all soils, capillary attraction will raise enough water to keep a subgrade wet at even greater distances than this above the water table. This difficulty with tile drainage systems is entirely aside from positive errors of installation, such as the use of tiles of too short a diameter, the use of tiles without bells, the use of gradients which are too light, etc., and is an elemental difficulty which, in our present knowledge of this subject, must be admitted as existing, but which is, as yet, unsolved.

Capillary Attraction

As illustrating to what an extent capillary attraction may affect the moisture content in the soil under a pavement, it will be interesting to many to know that one sample of soil taken just below a pavement in the business section of Washington, D. C., an asphalt pavement on a heavy concrete base, showed 12.23 per cent. of moisture by weight, which is approximately 32 per cent. by volume. The cut which had been made in the street where this sample was taken was about 10 ft. deep, but had not yet reached a level at which free water collected in the trench. In view of the nature of this pavement and of the fact that all of the ground for considerable distances in all directions from the point where this sample was taken is covered either by buildings or by sidewalks and pavements, it must be assumed that whatever water was found in the soil

under it had come to that level by being raised from below.

Here is a case, therefore, where capillary attraction had raised water enough practically to saturate a pavement foundation which is at least 10 ft. above the water table. In this particular case the soil under the pavement is clay. In its nearly saturated condition this clay is as plastic as good putty. Just what loads it will support has not been determined, but that if the water content in it could be reduced, its carrying capacity would be materially increased can hardly be doubted. This case has been cited because it shows very clearly the range over which capillary attraction may act, and the amount of moisture which may be involved. It is not, however, an isolated case, for the writer has found a good many pavement footings which contained even more moisture than this.

Heavy Clay Soils

As has been pointed out, tile drainage does not solve this problem. Tile drainage will remove any water subject to the action of gravity, but in heavy clay soils the per cent. of water so affected is so small that the actual level of complete saturation—the water table—is often hard to determine. The converse of this fact is that in heavy soils the percentage of water which may be raised by capillary attraction is very high and the distance through which the water may be raised is correspondingly great. Where the soil is subject to the direct action of the sun and the wind, the moisture raised by capillary attraction is evaporated, and so the large amount raised each season and dissipated through evaporation is unnoticed, but where the surface is covered by an impervious layer, as by a hard pavement or even by a board, the constantly rising moisture fails to escape as it does in the open country.

No Dry Subgrade

In fact, examinations of the water content in the soil under numerous hard pavements shows that even when the soil in the surrounding fields is so dry that plant life has withered, 30 to 40 per cent. (by volume) of water may be found in the soil immediately under the pavement. This would seem to make it clear that a pavement may so shield the subgrade that a high water content is preserved even during the dryer months, so high a moisture content, in fact, that it would seem fair to conclude that the much-talked-of "dry subgrade" is, for ordinarily humid regions, purely a myth.

Why "Dry" Subgrades Freeze

The significance of this condition of the subgrades composed of heavy material, even at elevations of 10 ft. or more above underlying water tables, is far-reaching. In the first place, it suggests a lower carrying capacity for subgrades than is usually assumed. But more in line with the subject matter of this discussion, it suggests a very cogent reason why so-called "well-drained, dry" subgrades freeze during cold weather, namely, that they are neither "well-drained" nor "dry." It may be, in fact it often is, true that they are "drained" in the approved fashion, but that they are "dry" is to be doubted, both from the fact that repeated examinations show that the soil under the pavements in the eastern half of the United States are almost never "dry," no matter how well they have been "drained," and beacuse, had they been dry, they most certainly could not have frozen.

Cracking of Pavements

As affecting hard surface roads, another matter of drainage deserves consideration, namely, the relation of water in the subgrade to the cracking of these pavements. It has been shown that capillary attraction supplies so much moisture that the soils under hard surface pavements are seldom dry. During cold weather the moisture in the soil freezes, solidifying the ground into a block often a number of feet thick. This process proceeds under a pavement just as it does in other places. However, this freezing causes little or no trouble. In fact, it is practically the uniform statement of engineers familiar with this matter that hard pavements go through the early winter without trouble. This is due to the fact that the freezing proceeds from the top downward and that the underlying soft earth takes up all of the expansion caused by the freezing.

As the winter proceeds, the surface of the ground now being a layer of ice-bound soil, winter thaws occur which melt the snow that is on the ground, and perhaps also a few inches of the soil. When this occurs a wholly different problem in road drainage is presented, for the water which is taken up by the melted soil on the surface cannot percolate into the lower strata because of the intervening layer of frozen ground. Under these conditions it may, and, in fact, often does, happen that the top of the ground becomes completely saturated.

The pavement, of course, protects the subgrade from the direct admission of water at such times as this, but this is by no means an adequate protection, not to mention a complete protection, for the complete saturation of the surface of the ground really amounts to nothing less than raising the water table to this level. Under such conditions, if the subgrade is level with or cut below the surrounding country, there is a distinct tendency for the plane of complete saturation to work its way under a pavement just as it does, for instance, under a house when the cellar fills with water from below.

More or less of the water in the soil at such times is in excess of what could be retained there by capillary attraction, and so is subject to comparatively rapid influence by the forces of gravity. Hence the distinct tendency of this surplus water to move rapidly into such places as the soil in a pavement footing, in response to the general principle that water will seek a level.

Rapidity of Capillary Action

Even when the pavement rests on an embankment it is subject to immediate effect under such conditions as this. As stated before, the saturation of the surface of the ground, under conditions which prevent the percolation of surface water into the lower strata, is, for all practical purposes, equivalent to the elevation of the water table to the level of the surface of the ground. Repeated experiments made by those who are investigating the movement of soil moisture, as affecting plant life, have shown that the rate of movement by capillary attraction may be very high where the lift is short.

Under the conditions here assumed, therefore—that is, where comparatively low embankments have been constructed over flat lands—the saturation of the top soil on the flat land will produce a condition almost exactly equivalent to that which would be produced if this land were actually flooded with water, and the effect on all of the subgrade which is thawed out, even if only a few inches of the surface and a few inches under the pavement have been thawed out, will, for all practical purposes, be the same. This is because capillary attraction will raise water even in a comparatively thin layer of thawed-out soil covering the surface of an embankment, just as water is raised by a wick, and will distribute it horizontally through the shoulders and under the pavement within the space of a very few days, or, if the shoulders and slopes are already wet, even within a few hours.

Of course, the rapidity with which a subgrade is wetted in this way depends both on its height and on the material of which it is composed, but as the subgrades usually used in highway construction are comparatively low, they are almost always within the range of capillary action.

In passing it might be noted that the major reason for objecting to free running water in ditches and to standing water on or near the right of way is based on this same general fact, namely, that capillary attraction will very promptly bring this water into the subgrade, where it acts to lessen the supporting power of the ground on which the pavement rests.

Spring "Break-Ups"

The result of the condition here discussed is weak subgrades. Highway engineers are thoroughly familiar with the

phenomenon known as the "spring break-up," especially as affecting gravel and macadam pavements. These "break-ups" are caused by the excessive softening of the subgrades under these pavements, and the softening is, in turn, caused by the excessive water brought into the subgrade by capillary attraction when the normal subdrainage of the soil is blocked by frozen soil underlying the surface of the ground, and a surplus of water consequently collects on the surface. No systems of drainage, as at present designed and installed, will care for this condition, for they are all likely to become clogged with ice during cold weather, or else they are so far below the surface that they are wholly cut off by the frozen block of ice-bound soil which overlies them.

As for hard-surface pavements, much breaking is, no doubt, due to positive overload during periods when these conditions have rendered the subgrades so wet as to be abnormally plastic, and consequently of low supporting power. The major part of the breaking of these pavements is, however, due to refreezing after the conditions above discussed have practically saturated any thawed-out portion of the subgrade. When the refreeze comes, conditions are different from those which prevailed at the time of the year when the subgrade was first frozen in this one particular, namely, that now the water which freezes is contained in a space between the pavement and the still unthawed portion of the originally frozen ground mass.

Freezing Under Pavements

It is not necessary to go into a long discussion of the phenomena of freezing. Suffice it to say that in freezing, the water caught between the pavement and the frozen ground exerts a tremendous positive force which is ample not only to crack heavy pavements, but to lift them considerably out of line. Moreover, the force developed in freezing is not usually relieved by a uniform movement in the overlying slab. If it was so relieved, all of a pavement block would be moved a small fraction of an inch and no great harm would be done. This does sometimes happen, but if it chances that conditions in the pavement initiate failure at some one point, all of the pressure is relieved at this point, in which case the distortion at this point may be considerable.

This is very similar to the process by which a boiler explodes. As long as the boiler holds, the pressure is equal on all parts of the interior. But when the stay bolts fail, the front plate may be blown clear out of the building. This, by the way, explains why one corner, or one edge, or one end, etc., of a pavement block may be raised a number of inches when the total expansion due to the freezing of a good many feet of water would not equal this amount. Of course, relief has occurred at a point, rather than by a general elevation of the block, and the excessive distortion is the result.

Use of Broken Stone or Telford Base

For the relief of this general condition the writer recommends the use of broken stone or telford base, unfilled with fine material and consequently containing voids so large that capillary action will not fill them with water. These footings should be deep enough to extend below the reach of late winter and early spring thaws and should be so drained to the ditches that no ordinary percolation, no matter from whatever source, can fill them with water. Such a system will be expensive, but it can hardly be doubted that it will be valuable enough in protecting pavements during spring weather to more than justify the necessary expense of its installation.

What Loads Can Subgrades Carry?

In closing, it is desired to point out that the careful consideration of the actual condition of pavement subgrades is becoming of more and more importance. Loadings are increasing rapidly and the highway engineer must either provide for these heavier loadings or definitely prove that they are not economically feasible. To do either he must be able to tell pretty definitely what his subgrades can be depended on to carry, and in order to arrive at this fact he must know how his footings are going to be affected both by the water which falls on the right of way and by that which comes to it in other ways.

The notes here presented outline the problem. They do not solve it. However, they are presented with the feeling that the longest step toward the solution of a problem has been taken when the problem itself is clearly stated. The solution will come in time, but pending the solution it will be well to act on the assumption that the greatest problems in land drainage lie under the ground and are often most a factor where their presence has at first been least suspected.

Experiences in Force Account Paving in the City of St. Paul, Minn.

By Oscar Claussen, Chief Engineer, Department of Public Works, St. Paul, Minn.

The most important municipal engineering work that is carried on by a city corporation is that of paving. Certainly the average large town in this country spends more money for pavements than it does for any other engineering work, and the city of St. Paul is no exception to this statement, as the following comparison will show:

Period		Approximate per cent of total
Expended for sewers during last 6 yrs.....(1912-1917)	$1,875,000	35%
Expended for grading during last 6 yrs.....(1912-1917)	624,000	12%
Expended for sidewalks during last 6 yrs.....(1912-1917)	243,000	4%
Expended for curbing during last 6 yrs.....(1912-1917)	120,000	2%
Expended for pavements during last 6 yrs.....(1912-1917)	2,480,000	47%
	$5,342,000	100%

With such figures at our disposal, the incentive and attempt to save money on construction of pavements would seem to be the imperative duty of the Department of Public Works, said Mr. Claussen, in addressing the St. Paul Civil Engineers' Society on May 20.

Local Conditions

When city force account paving was done for the first time in 1912 there was a demand for it by the public. The idea had impressed itself on the public that paving by contractors in previous years had been done poorly and that large profits were exacted. Barring some individual jobs, this idea was an erroneous one. As a general rule, pavements laid by contractors were well and substantially built, and in accordance with specifications, and the profits did not average more than 10 to 15 percent, in my judgment. Such profits are not exorbitant and not more than contractors should be entitled to. I believe this is generally conceded all over the United States. This 10 to 15 percent, applied to cost of pavements laid in St. Paul during the last six years, amounts to from $248,000 to $372,000, or enough money to maintain the Department of Public Works for the period of six years.

Realizing this condition of affairs in 1912, the opportunity of doing force account paving was grasped with enthusiasm, but with a mind fearful of what the practical results might be. Beginning with three paving jobs in 1912, the department has executed as high as 15 jobs in one year. Out of a total of 59 paving jobs executed during the last six years, 32 were done in competition with the lowest bids received from contractors and in each and every one of these 32 the actual cost of pave-

ment was less than contractors' lowest price bid. While in some cases the percentage of saving was very small, others were done where the contractors' lowest bid was 15 to 25 per cent higher than the actual cost of the pavement laid, the average of all jobs laid in competition being approximately 10 percent.

Importance of Cost Estimate

One of the most important operations involved in connection with force account pavement is the making and securing, as far as it is possible to do, of accurate estimates of cost, as these, of course, are the determining element in deciding, after bids are received, whether to let the work by contract or proceed to do it by force account.

Contrary to the belief of at least a large portion of the public, it is not possible for any engineer to figure or predetermine the exact cost of any piece of engineering work. Such an engineer has not yet been discovered and never will be. The engineer never gives the cost of the work; all he does and can do is to give an estimate of the cost, his estimate of cost being more or less close to the actual cost, in accordance with the experience, thorough knowledge and judgment he has about the particular kind and nature of the work to be performed. If the actual cost gets within 5 percent of the estimated cost, any engineer will consider it a lucky performance. If it were possible generally to predetermine the exact cost of engineering work, or even within 5 percent of the actual cost, contract work would be done only in exceptional cases. However, on some work it is much easier to make a fairly close estimate of cost than on other work, as will be shown.

The two items of an estimate of cost are labor and material. The quantity of or amount of material for a piece of engineering work is generally quite definitely called for and prescribed in plans and specifications, and therefore the cost of it can be quite accurately ascertained, but the labor, the second item of a cost estimate, cannot be readily predetermined and is very difficult to figure accurately. Therefore, on all engineering work where the percentage of cost of material of the total cost is large, and the percentage of labor is small, it is quite possible to make a fairly accurate estimate of cost, and, on the other hand, where the percentage of labor is large, and the percentage of material small, it is much more difficult to furnish an estimate of cost approximating the actual cost.

Material Cost, Largest Item, May Be Accurately Estimated

Now, on paving work, the cost of the material amounts to from 70 to 80 percent of the total cost, while the labor cost amounts only to from 20 to 30 percent of the total cost. Particularly is this true with block pavements, such as brick, sandstone or creosote block, therefore it is possible to arrive at fairly close actual cost figures of pavement work, both the quantity of material and the price of it being definitely known and constituting 80 percent of the total cost, while the amount of labor is not definitely known, but constituting only 20 per cent of the cost. For example, suppose the cost of finished pavement is estimated at $3 per square yard. Of this amount, say 80 percent, or $2.40, constitutes the cost of material, and is, within very narrow limits, definitely known, while 20 per cent, or 60c per square yard of finished pavement, constitutes the cost of labor, not definitely known and liable to vary greatly. Now, after the pavement is finished, we find that the labor item has been 50 percent more, or 90c per square yard, and the actual cost of pavement per square yard is $3.30 instead of $3; that is, while the item of labor was increased 50 percent over the estimate, the cost of completed pavement was increased only 10 percent. The above explanations are made for the purpose of showing that it is in fact possible for the engineer, with proper experience, to give an estimated cost of a paving job that approximates closely the actual cost. The engineer is in a position to know, within reasonable limits, what a pavement will cost, and therefore, in a given case, can figure in competition with a contractor whether he can do the work and save money over the contractor's figures or not. In other words, the risk and chances of the estimated cost being largely exceeded are very small. Therefore, because all elements entering into the cost of the work are fairly well known, and we know, within reasonable limits, what the actual cost of a pavement will be, barring accidents or mistakes, which may and do happen once in a while, we are in favor of force account work on pavement.

Labor Big and Uncertain Item on Sewer and Grading Costs

This reasoning does not hold good with sewer or grading work, which is the work next in importance and amount, as has been previously shown. For instance, in sewer work, the labor cost, which is the element of uncertainty, amounts to from 60 to 70 percent of the total cost for sewers up to 20-in. diameter, and constitutes about 40 percent for sewers as large as 4 or 5 ft. in diameter. If we should find, on a sewer job estimated at $20,000 ($13,000 for labor and $7,000 for material), that the labor item overran our estimate 50 percent, the sewer would cost $26,500, or about 33 percent more than estimated. With that happening we would be left in a fine predicament to explain the assessment figures to interested property holders.

An additional element of uncertainty as to cost of sewer work is the unknown nature of the ground and the possible presence of water, quicksand, boulders or rock; therefore, sewer work, whether done by force account or contract, is a mere gamble as to cost. Contractors largely guess at the cost, and sometimes guess right and frequently wrong.

With grading work similar conditions prevail; while the labor item on grading work generally constitutes 100 percent of the cost, and therefore is uncertain, the nature of the ground is not quite as uncertain as prevails with sewer work.

Therefore, because the cost of sewer and grading work cannot be ascertained and predetermined within reasonable limits, and because, in other words, the element of risk is too great, the department is not in favor of doing sewer and grading work by force account.

Where Best Men Set the Pace

Other reasons for favoring force account paving are as follows: It has already been stated that the main element of uncertainty in the cost of engineering work is the labor cost. Where the nature of the work is such that it will admit of employing laborers in squads under a competent foreman, all laborers working together as a unit to accomplish a cohesive piece of work, and where it is impossible for the individual laborer to shirk his allotted quota, where each man must do as much work as the best in the gang, and where the best man necessarily sets the pace, work can be done more cheaply and more can be accomplished than on such work where each individual does some work different from the others, where he does some separate job by himself, where one man's work does not directly affect the other man's work; in other words, where there is a chance for an individual to loaf on the job. On paving work the men largely work in squads. To begin with, there is the grading crew, then comes the concrete crew, and then the block-laying crew or the asphalt crew on asphalt work. Each man in his crew must work like a link in a chain, all doing equal amounts of work, and if one link breaks the entire operating mechanism is thrown out of gear. Laborers appreciate that this cannot be and is not tolerated, and, in fact, do not ask for it. It also necessarily means, in the nature of things, that strong, husky men must be employed, men that can accomplish a day's work. In this manner very efficient work is accomplished on paving work operations in contrast to a good many other municipal operations.

Claims Better Work Secured

Another reason why the Department of Public Works favors force account paving is that, on the whole, better work can be secured. It is not because contractors attempt delib-

erately to skimp the work. It is not intended to make this charge. However, contractors do rely and have a right to rely on the city's inspectors to watch the work and see that it is properly done. For the securing of good workmanship, the city must necessarily rely on various inspectors, more or less competent. Such men as the city can secure have at best only a limited knowledge of paving requirements; they are men whose technical qualifications are not of a high degree with reference to construction of pavements and whose salaries are low and whose employment is of a temporary and shifting nature. These inspectors cannot be employed throughout the year, and their services are needed only for a few months through the summer season, and each season a large number of new inspectors are employed. Men of special knowledge and experience, who can command and get adequate salaries, cannot, except in rare cases, be secured by the city under these conditions.

Costs Closely Kept

Another element in favor of force account work is the fact that the department keeps a very close cost record of all the labor operations carried on, as well as of the constantly varying costs of material, and in this manner valuable cost data are constantly at our disposal, allowing us to keep a close check on any bids submitted by contractors with reference to the profit figured in the job. Thus the contractor is always compelled to figure his work with a small margin of profit and submit a low bid. In this way, even if the work is done by contract, it is done at a lower figure than by competition with force account eliminated.

Claims Lower Costs

The primary reason, however, for the Department of Public Works favoring force account paving is the belief that a large saving in the cost of the work can be accomplished. The department does not, by any means, maintain that all pavements should be laid by force account. Each individual paving job should be considered by itself. At times the city may not have the proper organization at its disposal, at times it may not have the proper equipment readily available, or it may have more work to do for periods than can be conveniently handled, also the contractor may have made a mistake on bidding, for some reason or another, a lower figure than the department has estimated the cost of the work. At times the contractor's judgment as to the cost of the work may vary considerably from that of the engineer, and where this judgment dictates a figure considerably lower than the engineer's figure, ordinary prudence should demand that the work be performed by the contractor.

The Department of Public Works has never claimed that in all cases paving should be done by force account; it has never claimed that in all cases the work could be done cheaper by force account. Being just mere human beings, it is certain that on one or the other case the engineer's judgment will be at fault and the cost of a paving job will be more than the contractor's lowest bid price. Particularly is this true at the present time, when prices on material are varying from week to week and the element of labor expense is almost impossible to take into account adequately. To date the Department of Public Works has executed 32 paving jobs in competition with contractors' lowest bid price, and in each and every case a saving has accrued, the total saving on these 32 jobs amounting to $73,000, exclusive of depreciation charges. During the years 1913 and 1914 all paving work was ordered done by force account by the council without receiving bids from the contractors, and therefore on the 26 jobs executed in 1913 and 1914 by force account a comparison of contractors' bids cannot be made. However, the work done in 1914 comprised the largest program in paving ever carried out in this city in any one year, the cost amounting to $760,000, equal to 23½ miles on the basis of a 27-ft. roadway.

Conclusion

I would like to have it appreciated that what I have said about force account paving is not intended for propaganda; it is merely intended as an attempt to clarify the situation and bring out facts and arguments, from which, of course, engineers will draw their own conclusions. The Department of Public Works has attempted force account paving and advocated it in most cases because we believe it accrues and has accrued to the benefit of the public. Carrying on force account means to the department the expenditure of a large amount of energy over that required to carry on contract paving; also it means a great deal of worry. We have always felt that if we could not beat the lowest contractor's bid price, we would be subjected to a considerable amount of criticism by the public. We have never felt that it was possible to go along and do job after job against the lowest contractor's bid and beat him to it. It should be clear to every one that such a task is absolutely impossible, and if it did happen, would be a miracle. It is, of course, impossible to prove absolutely that force account is cheaper than contract work. If it could be done, there would be no controversy whatever about the proposition.

All that can be done is to present circumstantial evidence from data, arguments, past experience and actual results. In my judgment, contract paving, as a fixed policy, cannot be justified unless it is admitted that contractors will do work without a profit, and it would not be consistent or reasonable to assume that.

WATER WORKS DESIGN AND CONSTRUCTION

Design and Construction of Water and Sewerage Works at the Hog Island Shipyard

By W. H. Blood, Jr., 1305 Medical Arts Bldg., Philadelphia, Pa.

The construction of the Hog Island shipyard is one of the greatest engineering feats of the world. On September 13, 1917, Hog Island consisted of about 900 acres of desert land; there were no buildings on it, not a stick of timber, and not even a passable road. Today it is a mammoth shipyard, nearly completed, and practically in full operation. In fact, it is the largest shipyard in the world, and it contains one-quarter as many shipways as all of the shipyards in Great Britain combined. It is an industrial city of over 26,000 people, and as such has all the modern conveniences of the most up-to-date city of that size.

The American International Shipbuilding Corporation is responsible for this transformation, and in bringing it about has utilized the financial resources of the American International Corporation, the construction organization of Stone & Webster and the shipbuilding talent of the New York Shipbuilding Corporation.

The work of construction began in real earnest on September 20, and on June 20, 1918, the yard was 90 per cent. completed and had 30 steel ships under construction. The total

expenditures here under the existing contracts will practically equal those at Panama, but while the construction of Panama continued for 12 years, the work at Hog Island is to be completed in about 24 months.

Difficulties Surmounted

Work at Hog Island has gone on continuously through a winter of unprecedented severity, with labor conditions the worst in history, and in the face of inadequate transportation and housing facilities. The whole idea of the work here has been "speed," and all expenditures have been justified on this score. This has been a war measure and has been just as important as digging the front line trenches, where the whole job has been to get the work done quickly.

On a commercial basis, however, the charter value of the 180 ships which are being built here is $460,000 a day, or approximately $14,000,000 per month, so that it is evident that any expenditure up to $460,000 which would save a single day's time in the delivery of the ships would have been justified, to say nothing as to the value of the ships as a means of ending the war.

The readers of MUNICIPAL AND COUNTY ENGINEERING will be interested to know of some of the utilities which were constructed during the winter months, when the ground was frozen 3 to 5 ft. in depth, and the following paragraphs describe the water and sewerage systems which have been installed in this new industrial city.

CONSTRUCTION OF MAIN SEWER AND WATER TRENCH, HOG ISLAND, PA.
Left to Right: Main Trench, East—Main Trench East From Wharf Road—Main Trench, West.

The Domestic Water System

This system is designed to supply water for domestic purposes, for locomotives and heating plants, as well as to furnish fire protection in the barrack quarters, which have no high-pressure lines.

The domestic pumping station contains four motor-driven centrifugal pumps and two vacuum pumps used to prime the other pumps. Two of the centrifugal pumps, known as low-service pumps, are operated by 20-h.p. motors, and are used to pump the raw water through the 16-in. suction line from the Delaware river. The other two are used to pump the filtered water into the mains.

Water Purification Plant

The suction line at the river end has strainers to keep foreign matter from entering this line and causing injury to the pumps. These pumps are each capable of delivering 1,000 gals. per minute. Before the water has passed the low-service pumps, a solution of alum is put in the suction line. It then enters the subsidence tanks and is stored long enough to allow nearly all the suspended matter to settle to the bottom. There are four of these tanks, each 16 ft. high and 33 ft. in diameter. The water flows from these into the four units of the gravity filters, after which it enters the storage reservoir below the filters. On its way to the filters the first application of chlorine is made. The storage reservoir has a capacity of 150,000 gals. Each one of the filter units is capable of filtering 500,000 gals. per day.

USING THE LIVE STEAM METHOD OF THAWING FROZEN GROUND BEFORE EXCAVATING FOR HOG ISLAND WATER AND SEWER LINES.

The water in the reservoir is pumped directly into the distributing mains by the second pair of pumps mentioned. These pumps are driven by 75-h.p. motors, each having a capacity of 1,000 gals. per minute. Chlorine is applied to the filtered water as it enters the suction of these pumps. This has the effect of completely sterilizing the water.

The Distribution System

The distributing mains are laid on a gridiron system so as to obviate dead ends, and also to give uninterrupted service to

the majority of the lines in the case of a break in any one of them. Valves are also well distributed at intersections and along long lines so that it is possible to isolate short portions for repair and other purposes.

A 150,000-gal. steel tank and tower 125 ft. high, located near the center of the yard, also acts as an additional reservoir. An altitude valve at the base of this tank so works that it maintains the water in the tank at a fixed elevation when the pumps are working, but it permits it to feed into the distributing system when the pumps are closed down or when the rate of consumption is greater than the amount being supplied by the pumps.

Besides this steel tank there are four wooden tanks, with capacities ranging from 20,000 gals. to 60,000 gals., situated in various parts of the island. They are connected to standpipes for supplying locomotives with water. Altitude valves keep the water in the tanks at a fixed elevation.

As previously stated, this system also supplies fire protection for the barracks section. Hydrants are connected to the mains at frequent intervals throughout this district.

In case of a breakdown in the high-pressure and auxiliary pumping station it is possible to have the low-service pumps deliver water directly into the high-pressure lines.

in the high-pressure station. Both the high-pressure station and the auxiliary station serve the same lines. This system is also laid on the gridiron plan and is supplied with a generous number of valves.

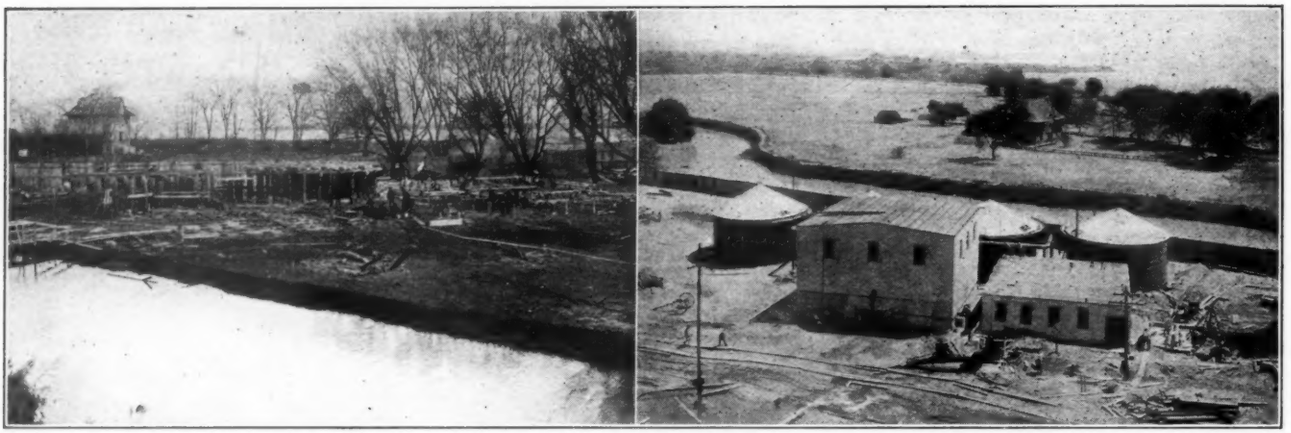
Hydrants

Fire hydrants are located at frequent intervals along all the streets throughout the shop district. As an additional precaution against fire on the shipways, there are two fire hydrants for each shipway on the Front street line, as well as additional fire lines with frequent hose connections on alternate shipway piers.

As stated in the description of the domestic water system, the low-service pumps can be made to pump into the high-pressure lines in case of a break in either the high-pressure or auxiliary pumping stations.

Hydrants with steamer connections are located at the end of each pier, so that additional water can be furnished by fire boats pumping into the lines through these connections. Water for the compressor houses is also furnished through this system.

The main lines range in diameter from 6-in. to 20-in.; 4-in. lines are used for connections to hydrants and for supplies to the compressor houses.



VIEWS OF THE DOMESTIC WATER FILTRATION PLANT AT HOG ISLAND, PA.
Left: Foundations for Filter Tanks, East End. Right: View of Completed Plant.

The following figures will give an idea of the amount of pipe laid on this system:

Suction line, 16-in. cast iron pipe, 450 ft.; other cast iron pipe lines as follows: 12-in., 1,400 ft.; 10-in., 3,900 ft.; 8-in., 14,650 ft.; 6-in., 19,870 ft.; and 4-in., 24,950 ft. Galvanized pipe: 3-in., 3,500 ft.; 2½-in., 1,600 ft.; 2-in., 22,000 ft.; ½-in. and 1½-in. service connections, 25,000 ft. Total length of metal pipe lines, 117,720 ft. There is also a 3,200-ft. 6-in. wooden pipe line. The total length of domestic water pipe lines is 22.9 miles. There are 28 4-in. hydrants on this system.

High-Pressure Fire Protection System

This system supplies water for fire protection for all of Hog Island, with the exception of the barrack quarters; for latrines along the ways, for the compressor houses and for testing ships, as well as sprinkler systems in various buildings.

The high-pressure pumping station contains 6 125-h.p. motor-driven centrifugal pumps, each capable of pumping 1,900 gals. per minute against a head of 148 ft., or they can be worked in series and have three units with a capacity of 1,900 g.p.m. each against a head of 296 ft.

The suction is a 24-in. cast iron pipe line 740 ft. long. Its lower end is attached to a double strainer to keep material from getting into and injuring the pump.

The auxiliary pumping station contains 4 125-h.p. motor-driven centrifugal pumps, with similar characteristics to those

All of the buildings which are heated throughout the yard have sprinkler systems in them. These buildings are mostly in the administrative group.

The following is the approximate length of the various sizes: 24-in. cast iron suction line, 750 ft.; other cast iron lines: 20-in., 575 ft.; 18-in., 2,500 ft.; 16-in., 4,800 ft.; 12-in., 4,200 ft.; 10-in., 16,500 ft.; 8-in., 39,200 ft.; 6-in., 6,800 ft.; 4-in., 1,000 ft. Also, 6,250 ft. of 5-in. screw pipe and 15,000 ft. of 1 to 2-in. service pipe. The total length of pipe in the high-pressure system is 18.5 miles. On this system there are 165 6-in. and 65 4-in. fire hydrants.

The Sewerage System

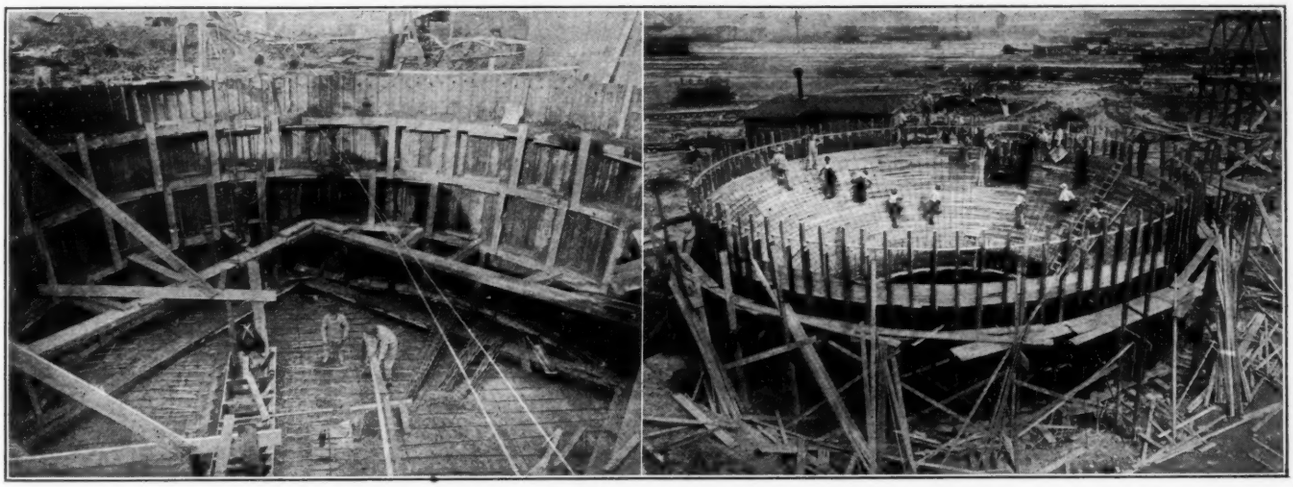
There are two main trunk sewers leading to the sewage disposal plant. Numerous laterals from these trunk lines cover the whole island.

On account of the very flat grades, that the topography of the island made necessary, flush tanks are placed at the dead end of every line. The tanks operate automatically once daily.

Sewage Pumping and Treatment

The sewage is brought by gravity to a cylindrical sump 37 ft. in diameter and 20 ft. deep. This is built of reinforced concrete. Three centrifugal pumps, each 1,500 g.p.m., operated by automatically controlled 25-h.p. motors, pump the sewage into Imhoff tanks. There are two of these tanks, built of reinforced concrete. They are of two-story type. The sludge

storage chamber is cylindrical in shape, with a cone-shaped bottom. The diameter of the cylinder is 29 ft.; the depth to the bottom of the cone is 19.5 ft. The upper portion is in the shape of a funnel 16.5 ft. deep and 49 ft. across the top. The total depth from top of tank to bottom of cone is 36 ft. These tanks each have a capacity of 1,500,000 gals. per day, and afford a retention period of 1½ hours. The effluent flows from these tanks to a disinfectant tank, where it is dosed with chlorine gas, and then through baffles into a small retention chamber, where it is held about 10 minutes. From here it runs through a 16-in. cast iron outfall into the Delaware river, discharging below low tide.



VIEWS SHOWING SEWAGE TANK CONSTRUCTION AT HOG ISLAND, PA.

The sludge is run on sludge beds at necessary intervals. These beds are two in number, one for each Imhoff tank. They are 108x125 ft., and are composed of a filtering material which allows the liquid to run off and thence back into the sewage sump. The sludge dries on the beds and is hauled away for disposal.

At the sewage sump it is possible to pump the sewage directly into the 16-in. outfall, thus by-passing both the Imhoff tanks and the disinfectant chamber. This, however, would be done only in case of both Imhoff tanks being out of service, in which case chlorine would be applied at the sump.

The sewers at the foreign barracks are lower than those in the north end of the other barrack quarters, so it is necessary to have an auxiliary sewage sump here. This is cylindrical in shape, 13 ft. deep and 20 ft. in diameter, and is built of reinforced concrete, and has two 5-h.p. motor-driven centrifugal pumps, each capable of pumping 1,900 g.p.m. They have automatic starters, which start the pumps when the sewage rises sufficiently high in the sump. The force main is constructed of 6-in. wood stave pipe. It discharges into a manhole in the barrack quarters and thence runs by gravity into the main sewer lines.

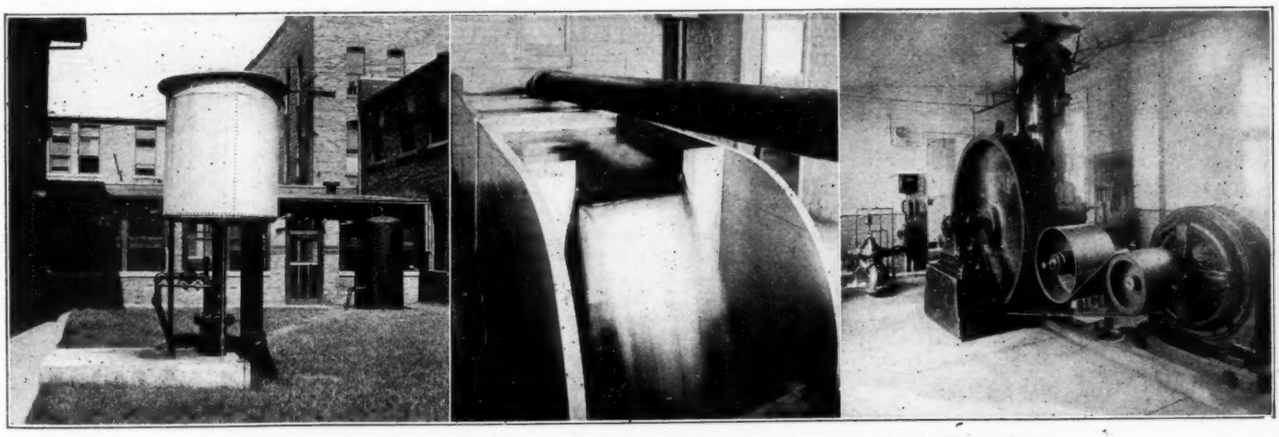
The main lines are from 8 to 24 ins. in diameter and the house connections mostly 6-in. The following is a schedule of the different lengths composing the system:

Wood pipe, 1,350 ft. of 6-in.; vitrified pipe: 6-in., 40,000 ft.; 8-in., 3,800 ft.; 10-in., 16,400 ft.; 12-in., 3,600 ft.; 15-in., 6,400 ft.; 18-in., 2,800 ft.; 22-in., 3,400 ft.; 24-in., 1,850 ft. There is also, in this system, a 1,500-ft. line of 16-in. cast iron pipe. The total length of sewers is 15.4 miles. There are 110 manholes and 18 flush tanks.

Performance of New Air-Lift Pumping Plant at Galesburg, Ill.

By John Oliphant, Chief Engineer, Pneumatic Pumping Department, Sullivan Machinery Co., Chicago

The city of Galesburg, Ill., has had considerable difficulty in securing sufficient water for the public supply. A number of wells in the neighborhood of the old pumping plant have been driven and equipped with various devices, but failed to give the amount of water needed. The old plant consists of three deep and six shallow wells, with a combined yield of about 250



VIEWS OF NEW AIR LIFT PUMPING EQUIPMENT AT GALESBURG, ILL.

Fig. 1, Left: Well and Collector Head in Center of Group of Municipal Buildings, Air Receiver at the Right Outside Engine Room. Fig. 2: Discharge Into Weir Box Over Concrete Storage Basin. Fig. 3: Air Compressor Short-Belt Connected to Electric Motor. At Left is Centrifugal Unit That Pumps Into the Water Mains.

gals. per minute, and has been very expensive to operate and maintain.

Under the present city administration the question of drilling a well at some distance from the old plant was taken up, under the direction of C. W. Whitney, and the Whitney Well Company was employed to drive a well to a depth of 1,250 ft. A strong flow of water was developed.

The New Well

The construction of this well was as follows: 40 ft. of 24-in. heavy steel casing; 106 ft. of 20-in.; 130 ft. of 16-in., and 350 ft. of 12-in. steel casing. The 12-in. is sealed in the rock. The hole was then drilled 12 ins. in diameter to a depth of 1,085 ft. from the surface, then reduced to 10 ins. and drilled down to 1,255 ft. through the St. Peter's sandstone formation.

The well was then shot with two 200-lb. charges of 100 per cent. gelatin, covering the entire sand rock strata, and carefully cleaned out.

Genuine wrought iron 10-in. pipe was installed and sealed into the top of the 12-in. pipe, approximately 350 ft. from the surface of the ground. This extends to within 3 ft. of the top of the sandstone strata, hermetically sealing the well from all water in the strata above the St. Peter sandstone. The analysis made from the water secured from the completed well was superior to that of all other wells in the territory, on account of the sealing off of the upper strata.

At the site of this well an auxiliary plant was constructed, lifting the water from the well to a small surface reservoir by means of the air lift. Thence the water is forced into the mains against 40 lbs. pressure with a centrifugal pump. The air lift and pump are operated by separate compressors.

Air-Lift Equipment

The air-lift equipment consists of one Sullivan angle-compound, Class "WJ-3" compressor, with 16x9¾x12-in. cylinders, arranged with short belt drive and unloading valve; one Sullivan standard 5-in. foot-piece (outside air line), and well-head with umbrella separator complete; one 42-in.x8-ft. vertical steel air receiver, and one 100-h.p. General Electric motor.

A float regulator was installed so that the water level in the receiving basin controls the amount of air delivered to the lift by unloading the compressor and regulating the water delivered to the centrifugal pump, which, in turn, is controlled through an electric governor by the city pressure, making the plant automatic throughout.

Conditions of Operation and Results of Test

The following are the conditions of operation and the results of the test on the well:

Number of wells	1
Depth	1,252 ft.
Water pipe in well	235 ft. 3 ins. of 5-in. 330 ft. 9 ins. of 6-in.
Main air pipe in well	235 ft. of 2-in. 331 ft. of 2½-in.

On account of the severe drop an auxiliary starting device was installed at a depth of 481 ft. 8 ins., to pump off the head and keep below excessive starting pressure.

Static head (from ground)	186 ft.
Drop	118 ft.
Elevation above surface	7 ft.
Total lift	311 ft.
Operating submergence	362 ft.
Percentage of submergence	35.8
Depth of pump in well	566 ft.
Operating pressure	121 lbs.
Starting pressure with auxiliary	129 lbs.
Gallons per minute pumped	450
Actual cubic feet of free air used	450
Revolutions of compressor	179
Water horse power, that is, ft. lbs. of work done	35.5
Operating horse power	94
Efficiency per cent	37½

High Efficiency Secured

The percentage of efficiency shown is considered excellent, and this result was made possible by careful proportioning of the sizes of air and water piping, proper location of the foot-piece or pump in the well, and by the use of the improved Sullivan foot-pieces, providing a continuous flow of water. In this design the air is discharged from the foot-piece into the water, in the well casing, in a multitude of fine jets, creating a very thorough mixture or emulsion of air and water. This action secures the maximum efficiency, as the chance of slippage is reduced to the minimum.

The accompanying views, taken at Galesburg, for this purpose, illustrate the new water stations.

Fig. 1 shows the location of the well in a court yard, in the center of the group of municipal buildings. The building at the left is the City Hall, and at the right is the rear of the fire station. The air compressor and pump are in the one-story engine room in the background. In the foreground is the well and collector head, in which the water stands about two-thirds full. The water is discharged in the large pipe at the right and is carried by gravity to the engine room. The air receiver is shown outside the building at the right.

In Fig. 2 is shown the water discharge pipe, coming into the weir box in the engine room. Over this weir the water is measured before falling into the concrete storage basin or cistern.

In Fig. 3 is shown the Sullivan angle compound air compressor, short belt connected to an electric motor. The vertical cylinder and a portion of the intercooler of the compressor may be seen, the low-pressure or horizontal cylinder being obscured by the flywheel. At the left is the centrifugal pump used for forcing the water from the storage reservoir into the city mains.

Mr. J. W. Thompson is chairman of the Galesburg Water Committee.

Recent Developments in Reinforced Concrete Pressure Pipe for Water Supply Lines

By Wallace R. Harris, Engineer Cement Products Bureau, Portland Cement Association, 111 West Washington St., Chicago, Ill.

Reinforced concrete pipe has been used for many different kinds of service, and now the art of manufacture has advanced to a point where a greater range of usefulness can be seen for this product. The progress from a split concrete pipe, for protecting wood piles from the teredo, to a reinforced concrete pipe suitable for water mains has been gradual, but sure.

Most engineers are familiar with the type of reinforced concrete pipe used for sewers, ranging in size from 24 ins. to 108 ins. in diameter, and may also know that reinforced concrete pipe has been designed for subaqueous lines, such as intakes for power house circulating systems, etc., but the latest development of a concrete pressure pipe suitable for water mains was only placed on the market the first part of this year.

Present Maximum Working Pressure

In general it may be said that although reinforced concrete pipe has been made to withstand 110 lbs. hydraulic pressure per square inch under test, such pipe is only furnished for pressures not exceeding 80 lbs. per square inch. Such pipe may be divided into two groups, one ranging in size from 36 ins. to 108 ins. in diameter, the other ranging from 12 ins. to 48 ins. in diameter, the first group being supplied with copper expansion joints and the second with a combination cast iron bell and spigot and lead gasket joint. The copper expansion joint pipe has been used with great success on water conduits

and pressure sewer mains, including the largest job of its kind, which consists of 10 miles of 66-in. pipe and 2½ miles of 48-in. pipe, on the Greater Winnipeg aqueduct, in the province of Manitoba.

Special Structural Advantages

Due to careful methods of manufacture and properly designed reinforcements, both types of pipe have ability to resist internal and external pressures, have a low coefficient of friction, and, due to the expansion joints and to the density of the concrete walls, the leakage is very low and will be found

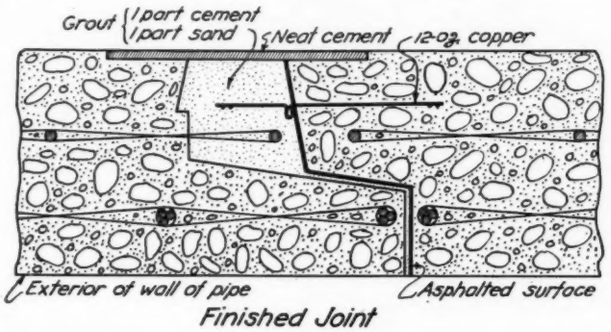


FIG. 1. DETAILS OF COPPER JOINT IN REINFORCED CONCRETE PRESSURE PIPE.

to be within the limits usually set as allowable leakage on water mains. The maintenance charges on such lines will be almost nil, as the line will grow stronger with age and can be considered of greater permanence than any other material capable of rendering similar service.

Two Types of Expansion Joints

The Copper Joint.—The two types of joints will be explained below, to illustrate the difference between the two types, as well as to indicate the advancement made.

In Fig. 1 it can be seen that a copper crimped band is cast in the spigot end of the pipe, so that the V-crimp comes at the top of the spigot, the other half of the band projecting from the spigot into the joint space which is created when two sections of pipe are joined ready for the mortar joint. The copper is roughly perforated along its two edges so that a mechanical bond will be secured with both the concrete in the spigot of the pipe and also with the joint mortar. The edge of the spigot is given a coat of asphalt paint to form a line of parting so the joint mortar will not bond to the spigot face. That part of the bell coming in contact with the joint mortar is roughened and a strand of mesh reinforcement is caused to project into the joint space so as to provide additional means for bonding the joint mortar to the bell end of the pipe. The primary joint, composed of 1:1 Portland cement mortar, is placed in such a manner as to obtain good contact with the copper, and the secondary joint, made of reground neat Portland cement, is placed. When the pipe contracts, due to lowering of the temperature of the water, the secondary joint cracks

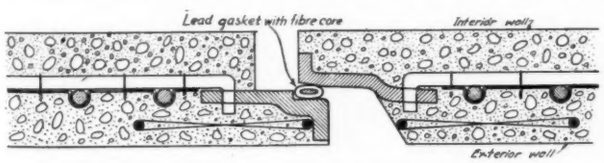


FIG. 2. LEAD GASKET JOINT, REINFORCED CONCRETE PRESSURE PIPE. SPIGOT IN POSITION TO FORCE HOME.

at the parting line above the V-crimp in the copper, and, having no bond with the asphalted surface, the joint follows the bell end in its movement toward the center of each pipe and pulls the copper, thereby opening the V-crimp, but still maintaining a tight joint, through which water cannot escape. When the temperature of the water raises the crimp closes. This type of joint has fully demonstrated in practice its usefulness.

Lead Gasket Joint.—Fig. 2 shows a section of the lead gasket joint as the spigot is in position to be forced home. The cast iron rings, which have been turned to a true circle on those faces which come in contact with the lead gasket, are cast integrally in the concrete pipe and are rigidly held in correct alignment by the longitudinal steel rods, which engage respectively in holes provided for the purpose in the cast iron bell and spigot rings. It will be noticed that one of the castings, that in the bell end of the pipe, has been machined in such a manner as to provide a seat for the gasket, which seat has a shoulder against which the lead pipe is forced, and a partly depressed cut forming half of a dovetail. This depression causes the gasket to be thicker at that point than at the edge nearest the outside joint line and prevents the gasket being pulled out of place when the pipes contract. The gasket is prepared by drawing a fiber core into a thin lead pipe, the core being tightly compressed in the act of drawing. This pipe is then flattened, turned into a circle and soldered to an exact circumference. The several points of design mentioned above are necessary to produce a joint which under pressure can be opened for as much as ¾ in., and which will allow the pipes to be deflected as much as 6 or 7 degrees without any leakage occurring.

Fig. 3 shows a section of the joint as it appears with the pipe pushed to place, with the gasket forced to its seat, with a resultant change in cross-section.

This type of pipe, in sizes of from 12 ins. to 48 ins., will be made in lengths of 12 ft., and can be provided with a simple form of service connection, whereby small lines can be connected without leakage while the pipe is under pressure, and which will only require excavation to be carried to the top of the pipe. This construction feature will increase the range of usefulness for this kind of pipe.

The city of St. Johns, N. B., will lay some of this pipe on a 48-in. water line during this year. The Lock Joint Pipe Company, of New York, manufactures these two types of pipe.

Increasing the Well Water Supply of Montgomery, Alabama

By A. O. Beauchemin, Hydraulic Engineer, Memphis, Tenn.

Contract for developing a 2,000,000-gal. well water supply for the city of Montgomery, Ala., was recently awarded to the Layne & Bowler Company, of Memphis, Tenn. This article describes the present well water supply, the proposed development, and gives in brief form the results of the studies made in connection with this development.

Present Well Water Supply

The city's water supply is procured from two sources: the river and deep wells. The river water is used exclusively for industrial purposes. The well water is used for domestic and

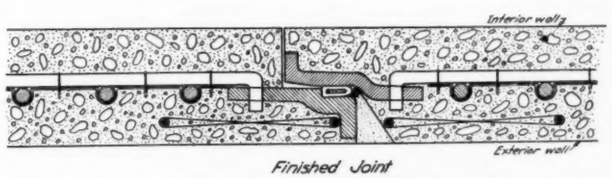


FIG. 3. LEAD GASKET JOINT, REINFORCED CONCRETE PRESSURE PIPE. PIPE IN PLACE AND GASKET SEATED.

industrial purposes. The present well water supply is procured from 18 wells, distributed within a radius of 1,000 ft. from the main pumping plant. The water is procured from three different strata: the 200, 400 and 600-ft. strata. The wells are distributed in groups as follows: Five wells are bored to the 200-ft. stratum, 10 wells to the 400-ft. stratum,

and 3 wells to the 600-ft. stratum. The water is lifted from the wells by means of a 3,000-cu.ft. air compressor direct connected to a 450-h.p. electric motor. From the wells the water is discharged into four concrete surface reservoirs, having a combined capacity of approximately 2,000,000 gals. From the surface reservoir the water is pumped to the city at 110 lbs. pressure by means of a centrifugal pump, directely connected to a 300-h.p. motor. The air compressor and high-pressure pump are in duplicate.

Production

In 1915 the water plane in these wells had been lowered so much as to necessitate a general cleaning of the well screens. An engineer was authorized to make the necessary repairs. The screens were all cleaned out and the submergence of the air line was increased. When these improvements had been made, the total production of the wells was 4,618,872 gals. per 24 hours, and the static head stood at an average depth of 71.2 ft. from the surface of the ground. The working head was then 125 ft. and the average air pressure was 61, with a submergence of 60 per cent. At the date of my investigation, June, 1918, the total production of the wells was found to be approximately 4,000,000 gals. per 24 hours, and the average static head was 89.6 ft., showing a reduction over 1915 of 18.4 ft., and the working head was 149 ft., an increase of 24 ft. over 1915. The average air pressure was 48 lbs. per square inch, a decrease of 13 lbs. since 1915.

Consumption

In addition to its normal consumption, the city of Montgomery has contracted with the War Department to supply Camp Sheridan with a maximum of 2,000,000 gals. of water daily, and the government is now building a large repair camp for aeroplanes, which will require a maximum of 250,000 gals. of water, making a total increase over the normal consumption of 2,250,000 gals. of water, or a total consumption of 6,250,000 gals. daily, while the total present well production does not exceed 4,000,000 gals. In order to meet the increased demand, the city had two alternatives—that is, to procure this additional supply from the present gathering ground or to bore wells outside of the present gathering ground.

The writer was called to investigate these two sources of supply and to report on them. If the additional water supply was procured from the present gathering ground the increase in draw down would be approximately 217 ft. from the surface of the ground. In order to meet this new condition, the air line in every well would have to be lowered in order to have sufficient submergency, and in its several wells which are bored to the 200-ft. stratum the air line cannot be extended. Therefore, the production of these wells would have been greatly reduced. Assuming that the air line could be increased in the other wells, the power required to lift 6,250,000 gals. out of the present gathering ground would be approximately 1,000 h.p., or an increase of 550 h.p. for an increase in production of 2,000,000 gals. In order to lift this water it would require an additional air compressor of 2,000 cu. ft. and one 2,000,000-gal. high-pressure pump. These two units should be in duplicate. Assuming that the draw-down in the wells would increase in the same proportion as during the previous three years, it would mean an increase of 40 ft. in the next ten years, making a total lift in the well of 257 ft., which would be impracticable on account of the high power consumption and the uncertainty of the water supply.

Resume

	4,000,000	6,250,000
Average depth to water level at submergence	47%	50%
H. P. required	450	1000
Cubic feet of free air	3000	5000
Number of wells	18	28

Estimated cost of two 2,000-ft. capacity air compressors directly connected to 600-h.p. motor $56,000
Two 2,000,000-gal. high-pressure pumps direct connected to 150-h.p. motor 10,000
Ten wells to a depth of 600 ft. 20,000
Pipe line, ground, buildings, foundation, etc. 6,000

Making a total cost of $92,000

The Layne System Adopted

At present the water is pumped at a pressure of 110 lbs. in order to lift the water to the upper part of the city, which is situated at an elevation of over 200 ft. above the main pumping station, and as the city has only one system, the lower town is supplied with water at a pressure of approximately 100 lbs., which is far in excess of the pressure required for domestic uses, with the result that a great quantity of water is wasted through leaks in the pipe line.

The Layne & Bowler Company, of Memphis, Tenn., submitted a proposition whereby they agreed to bore a series of large capacity wells about half way between the main pumping plant and Camp Sheridan. The wells are to be drilled at a distance of not less than 6,000 ft. from the present well location, which will be beyond the radius of influence of the present well system.

The new well system will supply the lower part of the city, situated north of Wetumpka Road, and Camp Sheridan, at a pressure of 70 lbs., thereby reducing the actual pressure by 40 lbs. This will considerably reduce the water wastage due to high pressure.

The Layne system will be connected to a surface reservoir at the main pumping station by means of an 8-in. automatic pressure regulating valve, which will automatically open when the pressure in the water system exceeds 70 lbs. and it will overflow into the surface reservoir, relieving the old well system of that much water.

A 75,000-gal. standpipe will be built at the base hospital at Camp Sheridan, and should, at peak load, the pressure decrease it will be equalized by the standpipe, so that a uniform pressure will practically be maintained throughout the day.

The Layne & Bowler Company estimate that they will produce a total of 2,000,000 gals. daily with three wells, which will be equipped with a Layne deep-well, high-pressure, motor-driven, centrifugal pump. The water from the wells will be pumped directly into the low-pressure system at a pressure of 80 lbs. at the discharge of the pump. Each pump will be directly connected to a vertical motor and the total horse power required to pump the 2,000,000 gals. at 70 lbs. pressure will be 250 h.p.

The well pumping units will be connected by an automatic control and each pump will be controlled from the main pumping house. In case of fire a gate valve, which will connect the high-pressure and low-pressure systems, will be opened, and the two systems will be operated at 110 lbs. pressure at a capacity of 6,250,000 gals. per day.

The new water supply will be located midway between the two points of consumption, which are the lower town and Camp Sheridan, and will have the following advantages: First, reduction in the loss of head due to the pipe friction; second, reducing the lift in the well system; third, reducing the domestic pressure from 110 lbs. to 70 lbs.; fourth, the efficiency of the new pumping system will be approximately 60 per cent. over all; fifth, the new wells will be beyond the radius of influence of the old system.

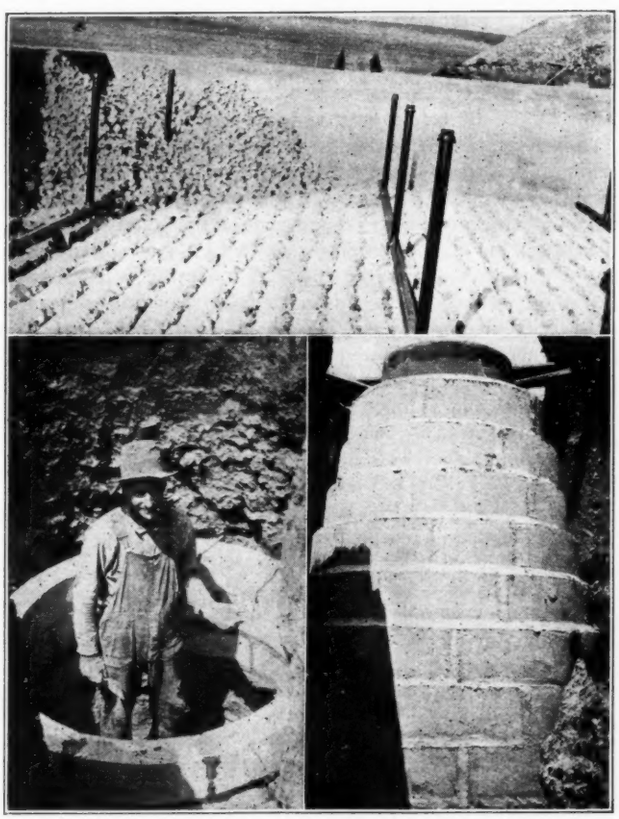
An important feature of the Layne system is that the clogging of the screen or strainer is practically impossible, due to the fact that with this system the velocity of the water entering the well through the shutter screen is so slow that the water does not carry any sand.

SEWER DESIGN AND CONSTRUCTION

Novel Sewerage System and Sewage Treatment Plant at Mt. Horeb, Wis.

By W. G. Kirchoffer, Sanitary and Hydraulic Engineer, Madison, Wis.

Mt. Horeb, Wis., claims the distinction of being the first village in Wisconsin to have its entire sewerage system constructed of cement concrete. The sewer pipe was manufactured by the Waupaca Sand and Gravel Company, Waupaca, Wis., and was composed entirely of cement and sand. The specifications followed for its manufacture were almost identical with those prepared by the engineering department of Kansas City, Mo.



VIEWS OF SEWERAGE WORKS AT MT. HOREB, WIS.
Top: Sprinkling Filter Under Construction. Bottom: Sewer Manhole of Cement Blocks Under Construction and Completed.

Some of the advantages considered in selecting this pipe were a more perfect joint, a smooth and uniform interior surface which would cause the least deposit, and about 14 per cent. greater carrying capacity than vitrified pipe.

Some of the disadvantages of the use of this pipe, as discovered during construction, are its weight as a drawback in handling, slightly larger and deeper trenches, greater porosity and difficulty in cutting to an exact line or shape at terminal points or in manholes. However, on the whole, we considered the advantages were greater than the disadvantages.

The manholes were all built of cement blocks, cast in an arc of a circle. These blocks, from the contractor's standpoint, at least, were an improvement over brick, considering cost and ease of building the manholes. They should also prove to be will prove whether they will disintegrate faster than brick.

The sewage disposal plant was constructed entirely of concrete. It consists of a settling tank, a sludge digestion chameconomical from the standpoint of durability, but only time ber, a siphon chamber, a sludge drying bed and a sprinkling filter. The plant was designed for a population of 800, with a daily average consumption of 100 gals. per capita. The settling tank has a capacity of a 2½-hour flow, assuming the entire flow to take place in 18 hours. The sprinkling filters have an area of 1,936 sq. ft. and a depth of 6 ft. The sprinkling nozzles are of the square Taylor type, spaced 11 ft. c.c. and operate under a maximum head of 6 ft. The contents of the siphon chamber are such as to cause the siphons to discharge at 20-minute intervals. The daily rate is 1,800,000 gals. per acre.

During the first winter of operation the volume of sewage was so small that all of the nozzles except one row were shut off and this row was housed in with rough lumber and buried with straw and manure. The plant is so located that it has no stream or open water into which the effluent can be discharged. The Galena limestone appears close to the surface at this point, and as it is extremely full of crevices the effluent was disposed of by constructing an underground pipe gallery (similar to galleries for the collection of water in water-bearing materials) on two sides of the filter into which the effluent discharges.

The plant has operated fairly satisfactorily, considering the care which it has received, which has been almost nothing, although the authorities promised the engineer they would care for it faithfully. On account of an excess of untreated creamery water being discharged into this plant, the underground filter has had to be extended, and from a recent date the plant will receive regular attention of a caretaker. The creamery waste will be treated in a specially designed tank before discharging into the sewerage system.

Mt. Horeb is located on a high ridge (known in the early history of Wisconsin as the military ridge), and drains into four dry valleys. This plant is the first one of four to be built and provides sewerage for the business section of the village. Other plants, slightly smaller, will have to be built in the other valley as occasion demands. These plants have not as yet been designed, but when they are needed they will be designed to fit the needs at that time and in accordance with the best prevailing practice, and particularly as may be indicated by the experience with this plant.

The sewers consist of 482 ft. of 6-in., 3,781 ft. of 8-in., 2,750.2 ft. of 10-in., 1,372.7 ft. of 12-in. concrete pipe, and cost $7,732.10. The sewage disposal plant, exclusive of rock excavation, cost $5,320.

Mr. C. H. Phillips, Waupaca, Wis., was contractor, and Ray A. Phelps, resident engineer, under the direction of W. G. Kirchoffer, who prepared the plans and had general supervision of the work.

Design Details of Proposed Works for the Collection and Disposal of Sewage at Pottstown, Pa.

By Charles E. Collins, Consulting Engineer, Drexel Building, Philadelphia, Pa.

In designing the proposed works for the collection and disposal of sewage at Pottstown, Pa., it was found that the

borough could be divided into a high and low level system, which, it is estimated, will ultimately save one-half of what it would cost to pump all the sewage to the disposal plant from one low level intercepting sewer. The borough has, therefore, been divided into two districts, a high level district from which all sewage flows by gravity to and through the disposal plant, and a low level district from which all sewage flows to the pumping station at the sewage disposal plant and is pumped into the settling tanks, from which it flows by gravity, together with the sewage from the high level district, through the disposal plant.

The sewers are designed on the separate sewerage plan; no rainwater from roofs or other areas is to be admitted into the sewers. The sewers are proportioned in size to accommodate the estimated future population on the basis of an average flow of 100 gallons per capita, for 24 hours, with a maximum hourly flow of 1½ times the average daily flow. The sewers larger than 6-in. and 8-in. in diameter when carrying the maximum amount of sewage for which they are designed are to flow between ½ and 2/3 full. The minimum size of sewer is to be 6-in. in diameter; therefore, there will be a large amount of 6-in. pipe that will not flow ½ to 2/3 full.

I have also substituted 8-in. for 6-in. in a few cases where a 6-in. would be large enough, but an 8-in. is more easily inspected, and in the cases where they are substituted for a 6-in. they have sufficient advantage to offset the small amount of extra cost.

The minimum grades are such as will give a velocity of about 2 ft. per second when flowing half full, and with the flushing that they will get from the flush tanks that are placed at the ends of flat sewers, should remain in good condition.

Population

The present population is estimated at 20,000 and the future population is estimated on the basis of 25 persons per 100 ft. of street for all streets within the high level district, and 20 persons per 100 ft. of street for all estimated future streets through vacant lands within the high-level sewerage district; 25 persons per 100 ft. of street for nearly all streets in the low-level sewerage district; 15 persons per 100 ft. of street for those streets not included in the above, and 15 persons per 100 ft. of estimated future streets through vacant lands in the low-level sewerage district, making a total estimated future population of 60,000 people, and the intercepting sewers have sufficient capacity to take care of the sewage from this population when flowing a little more than half full.

Ground Water

No water will be admitted excepting the unavoidable leakage, which is estimated at 135 gals. per 24 hours per 100 ft. of sewers, and in computing the sizes of sewers this amount of ground water is provided for.

Manholes and Flush Tanks

Manholes are placed at the intersection of all sewers and all changes of grades and alignment. Flush tanks are placed at the ends of sewers with flat grades.

House Connections

Connections with the sewers should be made only at Y's left in the sewer for this purpose, and only under the direction of a sewer inspector or superintendent of sewers. All house connections should be made of 4-in. first-class vitrified pipe laid on a grade of not less than 2 per cent.

The town council should adopt rules and regulations governing the making of these connections with the sewers, and also governing plumbing and drainage of buildings.

Care of System

The sewers are designed to be practically self-cleansing, and the grades are such as will produce under ordinary conditions self-cleaning velocities. It does not follow, however, that because a sewer has a self-cleansing velocity, it does not require any attention, because matter is often thrown or in some way admitted into a sewer that should not be, and if allowed to remain there would cause a great deal of trouble. I therefore advised that the sewers be carefully inspected at least twice each year, and if found foul, or in any way obstructed, they should be thoroughly flushed with water from the fire hose and thoroughly cleaned.

Sewage Disposal Plant

The sewage disposal plant consists of a pumping station on the low level intercepting sewer, a small tank in which the sewage from the high level and low level intercepting sewers comes together, an Imhoff settling tank, a small tank between the settling tank and dosing tank, dosing tank, sprinkling filter, effluent settling tank and sludge drying beds.

Pumping Station

The pumping station is a brick structure with reinforced concrete floor and concrete foundation equipped with two double suction centrifugal pumps of the volute type, each with a maximum capacity of not less than 1,200 gals. per minute, direct connected to two electric motors, the shaft of each pump to have a jaw coupling on opposite sides of pumps from the motors. These jaw couplings connect with a shaft on which there is a pulley driven by gas engine, so that the motors may be disconnected and either pump driven with the gas engine. A small air compressor is belted from the coupling between one of the motors and the pump which operates the sewage ejector in the pit below the basement floor.

The sewage from the low level system enters the pumping station at elevation 124.25, passes through two small tanks containing a concrete baffle wall, sloping bottoms and concrete wall over which the sewage passes into the pump well. The purpose of this small tank is to serve as a grit chamber, the heavier matters settling and the larger floating matters being held by the baffle. In the bottom of these tanks are two pipes leading to the small ejector in a pit below the basement floor. At intervals the flow shall be deflected through one of these tanks by the stop plank at the inlet, and the heavy matter, scum and sewage pumped out of the other with the ejector into the force main beyond the pumps, and then the direction of flow changed to that tank and the other tank pumped out with the ejector. In this way the pumping of the heavy grit and coarse floating matter through the pumps is avoided, and it is expected that high efficiency pumps may be operated without trouble and with less cost and repair than could be if all grit and coarse matters were pumped through them. The efficiency of the ejector will be low, but the amount of sewage pumped by this ejector will be very small. The sewage flows from these tanks into a small pump well, from which it is pumped by two centrifugal pumps of the volute type into the small tank outside of the settling tank. At this point the sewage from the high and low level districts comes together and passes by gravity into the settling tank.

Settling Tanks

These tanks are of the Imhoff type and have two compartments, the upper compartment being the settling chamber and the lower the sludge compartment. The sewage enters the tank through the concrete weirs or notches in the concrete channel wall at one end of the tank, passing under a concrete baffle in the center of the tank, and also under the small removable plank baffles at the outlets. The outlets are weirs or notches in the concrete channel wall, the same as the inlets. After the effluent passes out of the tank it flows around one side of the tank in a concrete channel into a small tank and over the side wall of this tank into the dosing tank.

By changing the stop planks that are placed in the concrete channels where the sewage enters the settling tanks, the flow may be changed so that it will pass through the tanks in either direction. As the sewage passes through the tanks the heavy sludge particles sink to the bottom and slide down the sloping walls into the lower compartment, where it undergoes further

decomposition. The tanks are of sufficient capacity so that the sewage will be between two and three hours in passing through the tanks when operating at full capacity, while the sludge compartment is of sufficient capacity to hold the sludge that will be deposited in about six months.

A water pipe is placed in the lower compartment, so that the sludge may be stirred up with a stream of water; this loosening of the sludge aids in the decomposition of the organic matter; the light scum arising on the sides of the sludge compartment may be removed from the top. An 8-in. sludge pipe is placed in the bottom of each sludge compartment for drawing off the sludge that settles in these compartments.

The object of the small tank between the settling tank and the dosing tank is to distribute the flow over the entire end wall of the dosing tank and prevent a heavy volume of sewage from floating down the side of the tank at one point when the tank is empty. Also to give an opportunity to screen the sewage at this point if found necessary, but as I have had a very similar plant in operation for two years without screening the effluent, I do not think screening will be necessary.

Dosing Tank

The sewage passes into the dosing tank, and as it reaches elevation 149.50 it is discharged into the pipes leading to the sprinkling nozzles and is sprayed over the stone filter. This tank is to be constructed of reinforced concrete and will be equipped with a Miller syphon, or equal, which will operate automatically, drawing a depth of 6 ft. in the tank. This is designed to give a maximum head of 8 ft. and a minimum head of 2 ft. on the crest of the nozzles, with 240 Taylor square spray nozzles in operation.

Filter

The filter is a sprinkling filter 20 ft. by 217 ft. 6 in., with a depth of 6 ft. 6 in. at the walls and 5 ft. 9 in. at the center. The walls are reinforced concrete and the floor of plain concrete. The main feeder pipe from the syphon will be 30 in. in diameter, discharging through a tee into a 24-in. cast iron pipe in each direction, reduced to 16 in. in diameter at each end, provided with 8-in. tees for each branch feeder pipe. An 8-in. valve is placed between the main feeder pipe, and these branch feeder pipes are to be 8-in. cast iron pipe and to extend through the opposite wall from which they enter and be fitted with a cap bolted to a flange end, so that the cap may be removed for cleaning. All feeder pipes are amply large, so as to keep the frictional losses low.

Sprinkling Nozzles

The sprinkling nozzles are to be the Taylor square spray nozzle, or equal, attached to a short piece of 2-in. pipe screwed into the flange of a cap bolted to a tee in the feeder pipe. The crest of the nozzles will be 6 in. above the surface of the filter.

Underdrains

The underdrains consist of two channel pipes, the lower pipe to be in 2-ft. lengths, laid to true grades on 9-in. centers and imbedded in the concrete floor; the top channel pipe to be in 1-ft. lengths, laid with 1-in. open joints. These underdrains are on a grade of .073 ft. per 100 ft., discharging through the four walls into a concrete channel in which the effluent flows to one point at the southwest corner of the filter, and from this point in an open channel to the effluent settling tank. The ends of all the underdrains are open so as to admit a free circulation of air through the drains and filter.

Effluent Settling Tanks

These tanks are reinforced concrete walls and plain concrete floors. The effluent passes into these tanks over a weir in the end of each tank, the tanks being of sufficient width and depth so that the velocity of the flow through the tank is very slow and allows any solids that may have flaked off the filter to settle in the tank, while the effluent flows through the pipe to the river. They are so arranged that the flow may be diverted through either tank while the other is being cleaned. These tanks are so located and at such an elevation as will permit dosing the effluent with a germicide in the channel between the filter and the tanks, if this is found necessary or advisable at any time in the future. The dosing tank for mixing and regulating the amount of disinfectant would be in the pumping station, and could be readily so arranged that the operating of the pump would regulate the dosing of the effluent. The effluent, after receiving the disinfectant, would pass into the tanks, giving it ample time to be thoroughly sterilized before passing off to the river.

Sludge Drying Beds

Sludge will flow from the settling tanks through an 8-in. sludge pipe into an open concrete channel, from which it flows through shear gates onto the drying bed. The flow can be regulated and the sludge well distributed through these gates. The surface material of the beds will be coarse sand, under which will be 3 in. of broken stone from ⅛ to ¼ in. in size, and below this the broken stone will vary from 1½ in. to 2 in. in size. Filtering material will average 14 in. in depth. The beds will be drained through 3-in. sewer pipe with open joints, sloping from the side of each bed to an 8-in. drain in the center of the bed. This 8-in. drain will discharge into the 10-in. cast iron clean-out pipe from the high level intercepting sewer, through which it flows into the pump well.

Capacity of Plant

In determining upon the capacity of this plant I have assumed that 80 per cent. of the total population of the borough will be served by the sewerage system in not less than two years after the sewers are completed, and after this time the proportion of the total population being served by this sewerage system will remain approximately 80 per cent. of the total population of the borough. On this basis I have determined upon a capacity of plant for 16,000 persons, although I think it will be found to be of sufficient capacity to treat the sewage from between 18,000 and 20,000 people.

Operation and Care of Plant

The plant is designed to be, as far as practical, automatic in its operation, and I believe will give good results with a minimum amount of care. Pumps will be driven by direct-connecting electric motors. Each motor will be connected with an automatic starter and float switch. This float switch will be set so that the motor goes into operation when the sewage in the pump well reaches a certain elevation, and also stops when the sewage reaches a lower elevation. It is intended, however, that one pump will ultimately remain in operation nearly continuously the greater part of the time. When one pump is in operation the float switch connected with the other motor will be set so that should a break-down occur the motor out of use will automatically go into operation. There is also a gas engine connected between both pumps, so that in case the electric power plant should shut down, the gas engine may be put into use.

After the sewage is pumped from the low level intercepting pump into the small tank outside of the settling tank into which the sewage from the high level intercepting sewer also enters, it flows by gravity from there through the entire plant.

Provision, as described above, is made in the settling tank to reverse the flow, the object being to deposit the sludge as uniformly as possible in the sludge compartment. These settling tanks should be in operation for about eight months before any sludge is drawn off, and then I believe it will be found best to draw off a small amount about once each month except during the colder winter months, when the drawing off of the sludge may be omitted. This should, however, be determined upon by the conditions found to exist when the plant is in operation.

Two attendants in the day and one at night should be sufficient to keep the plant in operation in the most satisfactory

manner. One of the day attendants should be competent to take care of the machinery and see that it is kept in proper condition and properly operated. The work about the plant outside of the pumping station will, in a general way, consist of freeing any nozzles that may become clogged, see that all the channels and dosing tank are kept clean, and do such other work as will naturally come to the attention of any attendant. The high level intercepting sewer should also occasionally be flushed through the 10-in. cast iron pipe in Moser road, also through the 10-in. cast iron pipe along the filter.

The caps should occasionally be removed from the 8-in. feeder pipes and each pipe carefully cleaned with sewer rods, steel brush and scraper. The valve on the 8-in. feeder pipe should be cleaned while the line is being cleaned, and each line cleaned separately. While each line is being cleaned the nozzles should be removed and also thoroughly cleaned.

WATER WORKS MAINTENANCE AND OPERATION

Conversion of Small Steam Operated Pumping Stations Into Electrically Operated, Automatically Controlled Stations

By John W. Toyne, Engineer, 457 Farmers' Trust Bldg., South Bend, Ind.

Public utilities are facing a situation unparalleled in history. The requirements of the government in man-power and materials, both directly and through contracts occasioned by the greatest war of all time, must of necessity come first. However, it is equally essential that the health and energy of our communities be conserved, and to this end the public utilities must render adequate service.

With the coal production below normal, the available labor supply greatly diminished, and the cost of all materials advanced from 100 to 400 per cent., the utilities are compelled, by economic necessity, to give more intelligent consideration to their problems of operation, maintenance and extension than heretofore.

The larger utilities, especially the privately owned, have for some time past recognized the necessity of efficient operation; have made a study of fuels and economical combustion, and have equipped their plants with modern instruments that make possible a comparison of operation results with the most efficient attainable with their type of equipment. They have built up in the personnel of their organization a spirit of loyalty and efficiency that is, under intelligent direction, in a great measure nullifying the handicap of labor shortage and high prices.

Steam-Operated Water Utilities Hard Hit

Perhaps no utility is suffering more from the abnormal conditions obtaining than the steam-operated water utilities serving the smaller communities. In the majority of cases these utilities are municipally owned. They have been constructed without sufficient consideration being given to operating and maintenance costs, and are being conducted in such a manner that economical operation is an impossibility.

A small steam-operated water utility, serving a community of about 2,500, that recently came under the writer's observation, is an example typical of this condition.

The plant consists of a battery of three hand-fired tubular boilers, 66 ins. by 6 ft., set 28 ins. above the grates. The boilers have deteriorated to such an extent that a maximum pressure of only 60 lbs. is allowed by the State Inspection Department. They are being operated without the feed-water being pre-heated in any way. The pumping equipment consists of two duplex, double-acting, triple-expansion engines, of the direct-acting type, operating condensing, with 14-in. vacuum.

This plant is being operated without either draft gages or flue gas analyzer in the boiler room; without a recording gage of any kind; without an indicator for engine valve adjustments, and with no meter on the water discharge line. The operating force consists of two 12-hour crews, three day men and two night men. Such a condition seems improbable to one familiar with efficient operation, yet its occurrence is so predominant in the smaller utilities that it can hardly be considered exceptional.

Electrification Covers a Multitude of Sins

Perhaps no available solution of this problem, under present conditions, is more attractive or economical than that of electrification of the plant with automatic or semi-automatic control.

In approaching a proposiiton of this character an intelligent study of all of the component elements, together with the physical and social conditions obtaining, is necessary in order to really accomplish the desired results. A careful survey must be made of the present and immediate future requirements; to determine the quantity of water to be provided; to analyze the distribution to ascertain the friction head, in addition to the static head, that must be carried under extreme conditions; to study the availability and quantity of the supply in order to determine, on a basis of ultimate cost, the most economical method of pumping; to consider the characteristics of the electrical power, both as to cost and continuity, and to study the social development of the community, in order that future requirements may be anticipated without excessive cost or objectionable operating features.

After a survey of this character has been made, and the general plan decided on, it is important that careful consideration be given to the details, bearing in mind that the total cost of production is the real governing factor.

Cost, as used here, and as must be computed, includes not only power and attendance, but, of equal importance, the items of interest, depreciation and maintenance.

It is manifestly impossible to give any plan that would be susceptible of universal application, especially in an article of this nature.

Example of Successful Electrification

A water utility in the southern part of Michigan offers an excellent example of the results that may be attained by the electrification of a small steam-operated plant. This utility serves a community of about 1,500. The original power plant consisted of a battery of two tubular boilers and two direct-acting, deep-well steam pumping engines.

This plant has been changed to a motor drive, with automatic control. A survey of the source of water supply indicated that one of the old wells should be discontinued, as the two wells had been installed so close together that the area of influence prevented pumping both simultaneously at full capacity, and that a new well must be drilled. This was accordingly done, and the result attained through increased infiltration more than justified the expense incurred.

The pumping engines, motors and pressure-governed con-

trollers were carefully selected on the basis of ultimate cost, and are operating at an over-all efficiency in excess of 75 per cent., which is, taking into consideration that the pumping engines are of the deep-well type, especially good.

The power is purchased at regular commercial rates from a power company operating in the community, and is very reliable, both as to the characteristics of the current and the continuity of the service.

This plant has been in service nearly a year, and to date the labor requirement for operation and maintenance has averaged about one hour daily.

The reduction in cost of operation and maintenance attained in this instance by electrification of the plant, and the change made from manual to automatic control, is slightly in excess of 75 per cent., and the saving effected is paying 40 per cent. net annually on the cost of the improvement.

This is not a brief in behalf of the electrical central stations, neither is it a criticism directed at municipal ownership, for the theory of community ownership of community utilities is above criticism, and the principles involved apply equally, regardless of ownership, whether municipal, corporate or private. It is a plea for an intelligent study of the actual conditions that obtain in connection with each utility and the rational application of the results of such investigations, as in this way only can efficient operation be secured and the resources of the utilities be conserved.

Pumpage of Wasted Water in Chicago Consumes 100,000 Tons of Coal Annually

One hundred thousand tons of coal, enough to heat the homes of 10,000 families through a cold winter, are wasted each year in Chicago in pumping water that is wasted, according to a special report on universal metering for the city, recently issued by the Chicago Bureau of Public Efficiency.

Eight and one-half per cent. of the water accounts are meter accounts, registering 25 per cent. of the water used and 47 per cent. of the city's water revenue, which last year was about $7,500,000.

The report was issued in support of the proposed ordinance then before the city council, which provides for universal metering at no expense to the consumer, retaining the present rate of 6¼ cts. per 1,000 gals., "with a minimum yearly charge of $4 per single household and $3 for each additional occupancy served by the same meter."

Shows Possible Saving

The report analyzed the situation with reference to leaks and wastes and the economical possibilities of a universal meter system, as follows:

Not less than 100,000 tons of coal are consumed annually in the pumping of water that is never used by any one. The need for fuel conservation in the future will be apparent to every one.

Expenditures from the water fund since the beginning of 1915 have exceeded the water revenue by nearly $4,000,000. In 1917 there was a deficit which necessitated the borrowing of $500,000 on water certificates, and it will be necessary to borrow a like amount, and possibly more, during 1918. The present depleted condition of the water fund is due largely to the drain upon it for tunnels, pumps and mains that would not be required but for the excessive amount of waste and leakage which prevails.

If through universal metering this waste and leakage can be brought under reasonable control within the next ten years, as is contemplated by the pending ordinance, the construction of tunnels, pumping stations and mains can be largely stopped for a long period, and the net saving which will result, even after the cost of installing, maintaining and reading the meters is taken into account, will mean that an increase in water rates can be avoided. The aggregate net saving between now and 1950 is estimated at not less than $135,000,000.

Half the Water Wasted

The Chicago water works is pumping an average of 260 gals. of water daily for every man, woman and child in the city. This is about twice as much water per person as most other American cities find ample to supply their requirements. Cleveland and Milwaukee, lake cities where conditions of supply and distribution are similar to those in Chicago, and where universal metering prevails, have a daily pumpage of less than 125 gals. per person. And their service is much better than ours.

Not more than half the water pumped in Chicago is ever really used. The other half is lost through waste and leakage. This loss is due to leaks in the pumps, in the mains and service pipes, and in house plumbing. It is due also in some cases to either careless or willful waste on the part of consumers. Meters are proposed as a means of locating and checking so far as practicable the loss of water which is of no use to any one. They are not intended to discourage the use of water in abundance, and experience in other cities shows that they do not in fact discourage such use.

REFUSE COLLECTION AND DISPOSAL

Refuse Collection and the Present Demand for Garbage

By Samuel A. Greeley, Hydraulic and Sanitary Engineer, 64 West Randolph St., Chicago, Ill.

Demand for Garbage

With the frequent difficulties attending proper garbage disposal, it is odd to find in many cities of this country at the present time a demand for more garbage. Within the last few weeks the commissioner of public works of Chicago made a public request, through the press, for more garbage, asking that no garbage be burned in furnaces and incinerators that could properly be put into the garbage can. In other cities the demand for garbage is indicated by the enactment of new ordinances for the separation of garbage from other refuse and by measures for improved collection service. Obviously, this demand results from the reduced quantities of garbage and the increased prices of garbage products. These conditions give a new perspective to garbage collection and disposal problems. How may the inherent dangers be avoided and the benefits secured?

Reduced Production of Garbage

As a result of the educational and restrictive measures of the government for food conservation under the able leadership of Mr. Hoover, there has been a marked and quite general reduction in the per capita production of garbage. This reduc-

tion from pre-war quantities has amounted roughly to from 10 to 25 per cent., some specific data being shown in Table I. On the whole, this reduced production is highly desirable and likely, to some extent, to continue.

TABLE I—REDUCED PRODUCTION OF GARBAGE.

City	Periods Compared: Larger Production	Lower Production	Percent Reduction*
Milwaukee	12 mo. 1916	12 mo. 1917	18.7
St. Paul	7 mo. July to Dec., 1916	Same period 1917	16.1
Rochester	12 mo. 1916	12 mo. 1917	20.1
Detroit	12 mo. 1916	12 mo. 1917	7.7
Columbus	12 mo. 1916	12 mo. 1917	21.5
Chicago	12 mo. 1916	12 mo. 1917	24.8
Springfield	1st 5 mo. 1916	Same period 1917	9.9

*Referred to larger production.

NOTE: Percentage reduction is based on total quantities, not per capita quantities of garbage.

Increased Value of Products

The most common products of garbage are pork from disposal by hog feeding, and grease, nitrogen, phosphoric acid, etc., from disposal by reduction. The increase in the market value of these products within the last 18 months has been almost beyond belief. The price of pork on the hoof has risen from $8 to $10 to upwards of $16 per hundred weight, or approximately double its pre-war price. Grease, which in 1914 brought around 4 cts. per pound and in 1917 6 cts. per pound, can now be sold for 11 to 12 cts. per pound. Some pertinent data is given in Table II.

Decreased Quantities of Products

Available records appear to indicate in some communities a moderate falling off in the quantities of products (pork, greases, etc.) recoverable from garbage, such as grease and tankage. This has presumably resulted from the generally adopted food conservation measures, although good business conditions, and, in particular, high wages, are compensating influences.

Separation of Garbage

The demand for garbage has led cities having mixed collection of all house refuse to undertake a separation of the garbage, and cities already having separate collection to seek methods of increasing the efficiency of the separation, so that more clean garbage will be collected. Such cities as Louisville, Ky., Seattle, Wash., Portland, Ore., San Francisco, Cal., New Orleans, La., and others heretofore operating under the mixed or no separation system, have started, or are considering, the separate system for collecting garbage free from ashes and rubbish. These measures obviously require marked changes in the established kitchen routine of many households, as well as adjustments of the collection service to the new demands. The situation offers opportunities for breaking away from costly, inefficient practices—opportunities which should not be overlooked.

Inherent Dangers

The principal danger in the adjustment to new conditions is that half-developed measures will be adopted. The chief source of complaint against refuse collection service in the past may be traced to this consideration. Methods of refuse collection (and disposal) have too often been developed from small beginnings along haphazard lines, following no general plan. The resulting systems are fastened upon cities by long use, despite high cost and inadequate service. Although it is now quite generally recognized that the collection of refuse is the most costly part of the problem and affects the convenience of householders most directly, nevertheless these facts are often overlooked in the operation of collection works. Special attention should be given to the following factors, among others:

Sanitary Requirements: (a) Frequency of collection. (b) Regularity of collection. (c) Service factor. (d) Type of wagon. (e) Washing the wagon. (f) Workmen.

Requirements for Economy: (a) Frequency of collection. (b) Type of wagon. (c) Equipment. (d) Variations in service. (e) Emergency work.

There is also a danger that methods of garbage disposal will not be sufficiently developed. Disposal of garbage by feeding to hogs and by reduction may result in odors and nuisance if the works are not properly built and operated. Over-zealous contractors, official bureaus and others have at times pictured the establishment of hog farms and separate collection systems on too easy terms. Some city officials have at times sought too high financial returns, such as can only be secured at the expense of cleanliness and good service. Rough sledding has been the fate of both contractors and the public. To avoid these dangers there is required a general plan and adequate attention to details.

TABLE II—VALUE OF PRODUCTS FROM GARBAGE.

Year	Market Price of Grease, Cents per Pound: Chicago	Cleveland	Columbus	Market Price of Tankage, Dollars per Ton: Chicago	Cleveland	Columbus
1913.....	....	4.26c	3.75c	....	$6.00	$6.79
1914.....	....	4.17	4.32	....	6.75	7.41
1915.....	....	4.41	3.76	....	8.75	7.00
1916.....	7.29c	6.50	5.17	$4.16	7.75	8.50
1917.....	7.34	8.00	7.50	4.16* 10.27**	9.58	10.84
1918.....	11.57	13.50	11.76	10.27* 16.85**	18.50	20.50

NOTE: *To August 1st. **Balance of year.

Benefits

The most obvious benefit is conservation. By saving the products of garbage the public is enriched. A cheap food for pork becomes available in greater quantities, there is more grease for soap and munitions, and also more fertilizer. The only justification for a deliberate waste of these products is a greater measure of public health protection. Obviously, special care should be taken to adopt methods of collection and disposal of separated garbage which can be maintained and operated in a clean and sanitary manner.

Of only secondary importance, however, is the benefit resulting from the opportunity offered of adopting improved methods of garbage and refuse collection. Frequently methods can be planned for a progressive development which can be partly financed by revenues secured from the garbage products. In any event, an opportunity is offered by the pressure of war conservation to put over improved methods of garbage collection and disposal.

Louisville Data

Since June, 1917, the writer has been consulting engineer at Louisville on refuse collection and disposal work. Through admirable co-operation on the part of Mr. Miller, of the Board of Public Works, Major Fricks, of the U. S. Public Health Service, the members of the special committee of the Woman's City Club and others, much progress has been made. The essential features of the preliminary investigation and recommendations were given in MUNICIPAL ENGINEERING for December, 1917. Since that time a new ordinance has been adopted, a new separate collection service has been extended to about 70 per cent. of the city, improved methods for the maintenance of dumps have been introduced and tests of garbage reduction and feeding to hogs have been made.

Of particular interest is the transition from mixed to separate collection. The existing school districts of the city were taken as a basis of organization because the Woman's City Club already had existing organizations in each school district. These districts were subdivided into collection districts, which were the unit for the introduction of the separate collections. Every house in each district was visited, the new ordinance explained, the type of can described, and a kitchen card left with the housekeeper. The permanent collection service then followed. During the first few weeks in the various districts, special records were kept of the number of

houses visited by each wagon, the amount of garbage collected, and other data necessary for planning collection equipment for the most economical service. The result has been a comparatively easy and complete adoption of the separate system. This portion of the work has been directed by Mr. Oeshger, superintendent of street cleaning; Miss Morrell, for the Woman's City Club, and Mr. Wischmeyer, for the Architects' and Engineers' Club.

Summary

There is at present a demand on the part of refuse collection departments for more garbage because of the relatively high prices of garbage products. Cities are introducing the separate collection service and are undertaking to improve their present systems. Opportunities are thus afforded for developing new and better methods. These opportunities should not be overlooked, and, in particular, half-way measures should be avoided both as regards collection and disposal. The resulting conservation of useful and valuable products is most desirable and should be exploited to the utmost consistent with public health protective measures.

WATER PURIFICATION AND SEWAGE TREATMENT

Sprinkling Filter System and Auxiliaries vs. the Activated Sludge Process

By T. Chalkley Hatton, Chief Engineer, Milwaukee Sewerage Commission, City Hall, Milwaukee, Wis.

Mr. Kenneth Allen closes his very admirable article on "The Development of Sewage Treatment," published in MUNICIPAL ENGINEERING for June, 1918, with the following words: "The means to realize the end should be the one that will be found not only most economical, but the one most generally acceptable from every point of view to those living near the plant, to the riparian owner and to the taxpayer."

This remark has struck the author as particularly appropriate at this period of the world's history, when so many lives are being sacrificed and so much property destroyed to demonstrate once for all the soundness of Christ's declaration that "we are our brother's keeper." We call it "Democracy," but it is really the principle involved in properly caring for the weak that the whole race may be benefited.

Economy to Taxpayer Not the Only Consideration

Mr. Allen suggests that economy to the taxpayer is not the only end to accomplish in providing for the disposition of the liquid wastes from a community, but that the inalienable rights of others must also be considered. A close examination of the practice not only of sewage disposal design, but subsequent operation, in the United States, forces one to the conclusion that in most instances the taxpayer has had the first consideration, and that others should be given only such rights as they might establish in court after an expensive litigation.

Consider for a moment the numbers of communities which have recently been haled into court by owners of property adjacent to the modern sewage disposal plant because of the vile and wretched odors emanating from the plant. The several pleas made by those communities are that the odors are not deleterious to health; or that the plant was established before human habitation in proximity to the plant; or that the design and operation of the plant was the best science could recommend!

Are these sufficient answers to the man who has built his home upon his own property, where he expected the comfort and protection given to his fellow-man in the more populous sections of the community? And are the damages which the courts usually allow him sufficient compensation for the breaking up of his home?

Consider again the riparian owner of a creek or small river. The fact of this body of water being a part of his property adds to its value very materially; it is useful to his comfort and welfare when in its natural condition; but when a community befouls it for the benefit of the taxpayer its usefulness to the riparian owner is gone and no damages which the court can give him will compensate him for its loss.

Is this carrying out the principle heretofore stated that we are our brother's keeper? Isn't it rather a good representation of the Kaiser's idea that the State is supreme and the individual rights are merely incidental?

Economic Considerations Given Too Much Weight

Economy has played too large a part in the development of sewage disposal processes up to the present time. Among leading sanitary engineers in the United States to-day it is the almost universal practice to recommend dilution as an important part of any process of sewage disposal, even though dilution may render a natural water course unfit for many of the purposes to which a riparian owner might wish to apply it.

The argument advanced has been that the natural means provided by the water itself should be utilized so far as possible, so long as the riparian owners don't kick; and if they do kick, pay them their price, which is likely to be less than the cost of treating the sewage to such a standard that the natural purity of the streams may be maintained.

The author has always objected to this argument, especially in view of the propaganda rapidly spreading throughout this country for the "city beautiful," by which it is intended to provide all means for the comfort, health and general satisfaction to the citizens of a municipality. If, in accomplishing this, the foul emanations from the municipality are deposited upon its neighbors to annoy them, the "city beautiful" idea is, to say the least, inconsistent.

A few years only have elapsed since most of the street cleaning was left to the natural elements; when garbage was deposited upon ground near the municipality and nature invited to do the rest; when most communities used such a supply of water as might be most available without any artificial treatment; but educational progress has taught us that these practices are inimical to public welfare. Although the cost has been enormous, all well-governed cities now insist upon clean streets, clean and wholesome water and the disposition of garbage without nuisance. Is it not pertinent to ask why the slipshod methods usually practiced in partially treating sewage should not be abolished and the work done right, even though the price may be high?

What Process Will Eliminate Nuisance

Those engaged in the art of sewage disposal are quite aware that disposal can be accomplished without causing a nuisance to anyone, providing expense is not to be the chief controlling element, and the writer believes that the profession will not enjoy the confidence of the public in sewage disposal matters until it insists upon having the disposal completed without nuisance to any legitimate rights.

This statement naturally brings forth the question as to what known process applicable to the average conditions will eliminate the nuisances to others caused by sewage or by the by-products from the methods of sewage treatment plants as now practiced.

It will doubtless be conceded by all readers that few, if any, of the present methods of sewage treatment produce a clear non-putrescible effluent; that all produce a sludge which is undesirable as a daily neighbor and that at times every such method produces odors which are neither pleasant nor wholesome; that the final disposition of the sludge is, after all, the greatest problem in a plant of any considerable size and that these disadvantages have been generally considered inseparable from the art.

With this concession granted it follows that a method of sewage treatment which will eliminate these disadvantages is most desirable providing the cost is not prohibitive and should be given very serious consideration in determining the type of plant most applicable to local conditions.

Comparison of Activated Sludge and Sprinkling Filter Processes

All municipalities in America of any considerable size which have, during the past decade, considered the installation of sewage treatment works have studied fine or coarse screening, sedimentation, sprinkling filters and chlorination, either as units, couplets or in other combinations. Fine screening or sedimentation followed by sprinkling filters and final sedimentation, and in some instances chlorination, briefly describes the treatment now most generally recommended where a non-putrescible effluent is required, and may be taken as the last word in sewage disposal so far as American practice is concerned. The Activated Sludge process, as recently developed, should therefore be compared with the sprinkling system and auxiliaries and all others thrown into the discard.

In making this comparison, however, the taxpayer should not be given the primary consideration, but should be placed upon an equal basis with the other interests at stake so far as that may be practicable.

In comparing the advantages and disadvantages of the two processes of treatment the following main items should be considered:

Variation in standard effluent.
Area required for plant.
Loss of head through plant.
Effect of temperatures.
Length of main outfall sewer to plant.
Clarification.
Odors.
Flies.
Disposal of sludge.
Cost of plant.
Cost of operation.

Variation in Standard Effluent

Both processes are susceptible of producing any standard effluent required. In sprinkling filters this can be done by varying the rate of flow through the filters. In activated sludge plants it can be done by the volume of air or contact period or both. This flexibility of either process is a valuable feature in many situations. With the suspended and settleable solids removed there are many periods during the year when a putrescible effluent might with impunity be discharged into running water swollen by spring freshets and polluted by surface scourings. Under such conditions the activated sludge process can be operated at decreased cost, whereas no saving can be experienced with sprinkling filters.

Area Required for the Plant

A well constructed and operated sprinkling filter plant with filter beds from 9 to 10 ft. deep should produce a uniform non-putrescible effluent from the average American municipal sewage at a rate of 2,500,000 gals. per acre.

An activated sludge plant under like conditions with 10 ft. depth of aeration tanks, should produce 10,000,000 gals. per acre and with 15 ft. tanks 15,000,000 gals.

The area required for the auxiliaries (except sludge drying beds), connected with the two types of plants will probably nearly balance; so that the sprinkling filter process will require from five to six times the area required by the activated sludge (exclusive of sludge disposal).

In the majority of cases this is a very important item. It is well known that even waste ground in the proximity of a municipality, when desired for sewage disposal purposes, automatically assumes values out of all proportions to its actual worth.

The Loss of Head Through Plant

The loss of head through a sprinkling filter plant should never be less than 12 ft.; whereas an activated sludge plant can be operated successfully with a loss of head of from 2 to 3 ft. from the surface elevation of the sewage in the grit or screen chamber to the surface elevation of the effluent in the outlet conduit.

In many situations the difference in the loss of head required means installation of a pumping plant with the increased operating expenses, and when a pumping plant would be required in either case it means an additional lift of from 9 to 10 ft.

Effect of Temperature

In climates north of the 42d degree parallel the efficiency of springling filters is reduced from 25% to 33% during the three winter months. To provide against this, extra area of beds should be provided. So far as observed the efficiency of the cultivated sludge process is but little affected by climatic conditions, although the indications are that it does require more air or a longer contact period when the temperature of the sewage falls below 45 degrees F. The evidence so far obtained, however, is not conclusive.

Length of Main Outfall Sewer to Plant

It will doubtless be conceded that a sprinkling filter plant should be located at considerable distance from present and prospective human habitation. This requires, in most instances, the building of a long and expensive outfall sewer to the plant.

On the other hand an activated sludge plant properly designed, built and operated can be built close by human habitations without creating a nuisance, because there are no odors, flies or other nuisances to offend the senses, which extend beyond the boundaries of the plant.

Clarification

The effluent from the best operated sprinkling filter plant cannot be said to be clear. So far as the author has observed, its turbidity runs from 40 to 75. The effluent from a properly operated activated sludge plant will carry a turbidity of not more than 90 and usually 95 to 98. In fact the clarity of the effluent produced from this type of plant is one of the wonders which attracts both the learned and novice.

This feature is of decided advantage because it does to a large extent create in the minds of the public a confidence that a satisfactory treatment is being given to the sewage.

Odors

There can be no doubt in the minds of anyone that sprinkling filters and their auxiliaries produce odors, at times, which are unpleasant and inimical to the comfort of persons coming in contact with them. These odors emanate from the preliminary settling tanks of whatever type, sprinkling filters and the sludge.

With a properly operated activated sludge plant no odors are produced which can be detected 200 ft. from their source. In fact, after operating a testing plant for 3 years, the author

has not been able to detect any unpleasant odors 150 ft. from the plant, and yet the sludges produced have been reduced to a fertilizer base by methods where the necessary refinements for reducing odors were not used.

Flies

Sprinkling filters produce myriads of flies and worms. It is questionable whether these become a nuisance to the surrounding neighborhood, but they do, at least, produce an unmitigated nuisance to those whose duties require them to work in and about the plant. Neither flies nor worms are produced about an activated sludge plant.

Disposal of Sludge

In most instances the disposal of the sludge from a sewage treatment plant is the most difficult problem to solve. There are few locations where the sludges can be disposed of as easily and with as little nuisance as at Atlanta, Rochester or Fitchburg, although it must be taken into consideration that this ease of disposal was the result of constructing long and expensive outfall sewers, part of the cost of which should be added to the cost of sludge disposal when comparing the two processes.

Under the ordinary local conditions, whether the sludges to be handled are produced from plain sedimentation, hydrolitic, or two-story tanks, this handling involves considerable labor, and costs, exclusive of overheads, from $2 to $5.50 per 1,000,000 gals. of sewage treated, so far as the author can determine from the meager information he has been able to accumulate.

The sludges produced from plain sedimentation, hydrolitic or Dortmund tanks are wet and putrid when exposed to the atmosphere, and must be lagooned, trenched, discharged upon low ground enclosed with dikes or deposited in separate digestion tanks; in every such case the odors arising from the decomposition are unpleasant and penetrating to a considerable distance.

The sludge from the two-story tanks is free from odors which carry to any considerable distance and can be removed from the tanks at such seasons of the year when climatic conditions are most favorable for drying. These are features which make the two-story tank attractive particularly in the northern sections of America, although there are but two or three months out of the 12 when the climatic conditions in the northern tiers of the United States are such that this sludge can be successfully dried within reasonable time, say from one to two weeks.

Even at the Baltimore plant, where numbers of separate digestion tanks have been provided, large additions to the sludge drying beds have been made to enable the operators to get the sludge dried within the period of the year when it can be done successfully. In municipalities such as St. Paul, Indianapolis, Milwaukee, Chicago, Detroit, Cleveland, and other northern cities, where the volume of sludge produced would be of considerable magnitude, the author is of the opinion that the ordinary sludge drying bed for sludges produced from two-story tanks would prove a failure, and that the Pratt glass covered beds or some such scheme would have to be adopted.

Lagooning, trenching, filling low lands, digestion tanks or drying beds require surface area and this area must be added to the area required for sprinkling filters, and depends upon the character of soil in the first three types, and the normal climate and size of digestion tanks provided in the last two types. Sludge drying beds have generally been provided on the basis of one-half to three quarters of one acre per 1,000,000 gals. of sewage treated. To a plant treating a daily flow of sewage of from 5,000,000 to 10,000,000 gals. or less this additional area does not assume so much importance, but when the daily flow runs up to 50,000,000 or more gallons the area required for sludge beds and that for the final disposition of the dried or partially dried sludge is a matter of great magnitude.

Reducing sludges produced from sedimentation tanks of one type or another to a fertilizer has been attempted in many instances with more or less success. The most recent instance of any magnitude is the operation at Baltimore where the partially dried sludge which has accumulated from the sludge drying beds since the beginning of the operation of the plant is being reduced to a low grade fertilizer by a contractor who has installed a primitive drying plant consisting of direct heat dryers, grinders and screens.

Mr. Reuter, superintendent in charge of the plant, informed the author in September, 1917, that he was producing the dried fertilizer at a cost of $2.82 per dry ton, exclusive of overheads, that it was sold to the fertilizer dealers for $2.50 per unit of available ammonia, and that it contained from 1.25 to 2 units per ton. Not a very attractive business, it is true, but the trouble seemed to be twofold—the crude and expensive method necessarily used in much of the plant and the low grade sludge.

The author was impressed with the great benefit enjoyed by the city of Baltimore from this operation. It was getting rid of a sludge, without expense to the city, which threatened in time to cover all its available ground with an undesirable product. It was getting rid of it without nuisance to its neighbors, and was adding to the wealth of the community by conserving those fertilizing values which would otherwise be utterly wasted.

The disposal of the sludge from an activated sludge plant becomes entirely a mechanical or industrial problem, and must be so recognized to make the process applicable to any condition.

As a wet product there is far more volume to be handled than is produced from any other process of sewage treatment; probably three to four times as much as is produced from chemical precipitation. When fresh it is odorless, but, being highly organic, decomposition begins soon after it is exposed to the atmosphere, and this character precludes it from being dried in the atmosphere. It constantly accumulates and must be handled as rapidly as possible. There are disadvantages of no mean proportions connected with the activated sludge process.

On the other hand the sludge, when reduced to a fertilizer base, contains from 4 to 5 units of available ammonia, which, during pre-war times, was worth $2.50 per unit, and is now much more valuable. From experiments made in Milwaukee and Chicago it can be dewatered by means of pressing and drying at a cost equal to or less than its selling value, and its value as a fertilizer has been practically demonstrated by Dr. Bartow at the University of Illinois, by Col. Nasmith's and Dr. McKay's experiments at Toronto, by Mr. W. Jones, of Stourbridge, England, and by the author in the vicinity of Milwaukee.

The equipment necessary to handle the sludge from a 100,000,000 gal. plant would occupy approximately three acres and would consist of settling tanks, press, dryer and storage houses.

In comparison with the sprinkling filter process the activated sludge process solves the sludge problem by compulsion without creating any nuisance to the neighborhood, and conserves those values of which the agricultural community always stands in need. This advantage is of value not only from the viewpoint of dollars and cents, but from the broader economic view of conservation.

Cost of Plants

It is a difficult matter to compare the cost of any two disposal plants fairly on the basis of volume of sewage treated. There are local conditions which usually require added expense in one which do not prevail in the other. Unless these

Table I—Construction Cost Comparisons of Sprinkling Filter and Activated Sludge Plants.

Comparable Items.	Sprinkling Filter Plants, Gloversville.		Fitchburg.	Activated Sludge Plant, Houston.
Capacity of plant in million gallons	3		4	10
Total cost exclusive of land and engineering	$164,036	*	$263,036	$301,526
Cost of plant per million gallons	54,680		65,700	30,152
**Approximate area in plant (acres)			4.17	1.0
Approximate gallons treated per acre	1,000,000		2,000,000	10,000,000
Approximate loss of head in feet	16		25.4	3.5

**Exclusive of ground required for final disposition of sludge.
*Exclusive of sand filters.

are well understood any such comparison is subject to doubt.

It is often most difficult to secure reliable information as to the actual cost of constructing a sewage disposal plant. The amount of contract can be determined, price of land occupied and cost of special machinery and equipment, but there are many other items such as engineering, inspection, superintendence and other contingencies entering into the cost which are so frequently omitted from any published statements.

For these reasons, and because the three plants chosen for comparison are, in the writer's opinion, the best of their type both in construction and in operation, he has taken the Gloversville, Fitchburg and Houston, Texas, plants. The first two are fine examples of the sprinkling filter type and the last the only large plant now built of the activated sludge type.

In comparing the cost of the plants the cost of the sand filter beds in the Gloversville plant has been omitted because it is not a part of the sprinkling filter system, but an auxiliary necessary for the treatment of the special character of sewage produced from the large number of tanneries, and is not common to other sprinkling systems; although it might be said that the sand filters tended to reduce the depth of the stone beds and to that extent reduced their cost.

The activated sludge plant at Houston has been in operation for about a year, at least the sewage treatment part of the process has been, the sludge reduction plant is now being installed, all necessary contracts therefore having been made under certain definite guarantees as to the cost of product; power, fuel and labor required.

It has been treating an average daily flow of 5,000,000 gals. of domestic sewage with little industrial waste, and has been producing, according to Mr. E. E. Sands' written statement to the author, a relative stability of about 70. Comparative Table I has been compiled from tables and information contained in American Sewerage Practice, Vol. III, pages 620 and 621, by Metcalf & Eddy, and from detailed statement of cost submitted by Mr. E. E. Sands, city engineer of Houston.

Cost of Operation

It is more difficult to secure accurate cost of operation than the cost of construction, and few data are available for comparative purposes. The three plants above cited, however, are exceptions to the rule, and will therefore be used.

The cost of disposing of the sludge in Houston is compiled from Mr. Sands' statements and are based upon the contract prices for machinery, installation, building, and the guarantees as hereinbefore mentioned.

The cost of operating the Fitchburg plant is taken from the 1917 Annual Report of the Sewerage Commission.

The cost of operating the Gloversville plant is taken from American Sewerage Practice, pages 624, and excludes the cost of removal and replacement of the filter covering.

In estimating the overhead expenses for the Houston plant liberal allowances have been made to cover maintenance. For instance, 5 per cent. depreciation has been allowed upon all machinery and 25 per cent. on Filtros diffuser plates. Cost of power has been taken at 1 ct. per kilowatt hour, the price now being paid by the city. Fuel for drying sludge has been assumed to cost 1 ct. per 82,000 B.t.u. Evaporation of 1 lb. of water per 1,350 B.t.u., or about 10 lbs. per pound of coal.

The writer prefers to have his reader draw his own conclusions as to the advantages or disadvantages of the two methods of sewage treatment discussed in this article. He has presented the facts as they have been presented to him during the last three years of intensive study and observation of the sewage disposal problem. He believes, however, that the activated sludge treatment solves the problem far more satisfactorily to all parties concerned than the sprinkling filter process, where a stable effluent is required and where power costs are not excessive.

Design and Construction of the New Water Purification Plant and Pumping Station at Checotah, Okla.

By V. V. Long, Benham Engineering Company, Consulting Engineers, Colcord Bldg., Oklahoma City, Okla.

After many delays, due to construction in war times, Checotah's new water purification plant and pumping station were placed in operation on June 8, 1918.

The plant is located on Deep Fork, seven miles southwest of Checotah, and consists of a low-service pumping station or intake well, coagulating basins, filters, and high-service pump house and clear well. The filtered water is discharged by the high-service pump through a 12-in. cast iron bell and spigot main into a concrete reservoir, from which the water flows by gravity through a 12-in. flow line to the city. A gravity head

Table II—Comparison of Cost of Operating Sprinkling Filter and Activated Sludge Plants.

Comparable Items.	Gloversville.	Fitchburg.	Houston.
Capacity of plant—Basis for computation	3,000,000	4,000,000	10,000,000
Overhead, 5% interest, 2½% depreciation	$11.24	$13.50	
Overhead, 5% interest, 3½% depreciation			$7.02
Operating costs, including sludge disposal	5.56	6.93	7.08*
Total costs per million gallons	16.80	20.43	14.10

*The total operating cost for reducing the sludge at Houston is estimated to be $8.40 per dry ton. One-half a dry ton is produced to million gallons of sewage. The value of the dry sludge is estimated at $11.25 per dry ton, or $2.50 per unit.

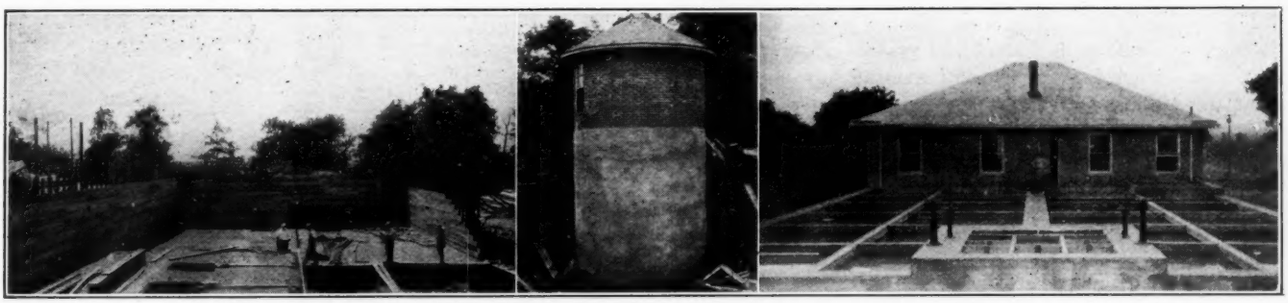
of 70 lbs. per square inch is maintained in the business section of the city.

The new plant has a normal capacity of 1,000,000 gals. per day. Both high and low-service pumps are in duplicate, each pump having a capacity of 750 gals. per minute. The pumps, as well as all the machinery, are motor-driven. The power is generated by the local light company in Checotah and delivered to the plant by transmission line.

There are four filter units, each 11½ ft. by 11 ft. Three units are now equipped, one unit being left for future equipment when required. There are two coagulating basins, each 23 ft. 6 ins. by 59 ft. by 13 ft. deep. These basins are so arranged as to be very flexible in operation and therefore especially adapted for treating water in all conditions. The basins can be used either in series or parallel, and one can be used while the other is being cleaned. Of special interest are the two agitators, which receive the raw water from the low-service pumps, and in which the water is treated with the chemicals and thoroughly agitated. Excellent results are obtained by the use of these agitators and the basins operate very successfully even when the raw water is at its worst stages.

Attention is called to the so-called "red water" which frequently is carried by Oklahoma streams and which is difficult to treat satisfactorily. In treating this "red water" better results were obtained by using lime and iron as coagulent than by the use of aluminum sulphate. The plant is equipped for using both iron or alum as coagulent, but it is anticipated that iron will generally be used. Three inches of head are necessary for the passage of the water through an agitator, when operating at the rate of 750 g.p.m., and the total loss of head from the entrance to the agitator to the water level on the filters, when operating at the rate of 750 g.p.m., is 8 ins., when the basins are being operated in series.

The water works improvements, which include the water purification plant and pumping station, discharge mains and flow lines to the city, cost approximately $130,000. Contracts were let for these improvements during April, 1917. The Tolbert Construction Company, of Muskogee, Okla., were the general contractors. The Pittsburgh Filter Manufacturing Company, of Pittsburgh, Pa., furnished the filter equipment, and the Merkle Machinery Company, of Kansas City, Mo., furnished and installed the pumping and electrical machinery. All the improvements were designed, and the construction supervised, by the Benham Engineering Company, consulting engineers, Oklahoma City, Okla.



VIEWS OF NEW WATER PURIFICATION WORKS AT CHECOTAH, OKLA.
Left to Right: Construction of Forms for Coagulating Basins—Intake Well, Low Service Pumping Station—Coagulating Basins and Filter House.

Design and Construction of the New Sewage Treatment Plant at Sedalia, Mo.

By Robert E. McDonnell, of Burns & McDonnell, Consulting Engineers, Interstate Bldg., Kansas City, Mo.

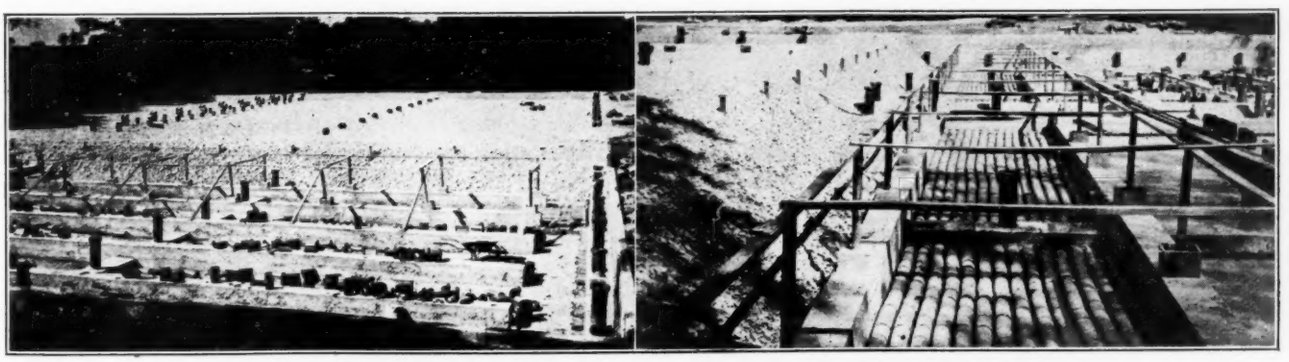
Sedalia is a city of nearly 20,000 population, located in the west central portion of Missouri. It is principally a residential city, and there are very few manufacturing enterprises; however, the Missouri Pacific and Missouri, Kansas & Texas Railroads have large shops located there. Sedalia is in the midst of a rich agricultural district and serves as a market outlet for this territory.

Early Plant Satisfactory

About eight years ago the city constructed a sewage treatment plant consisting of septic tanks and single contact beds, with a capacity of about 100,000 gals. per day, to serve the southeast portion of the city. This method of treatment was adopted on account of the low head available for a gravity plant, and has proved very economical and satisfactory for the local conditions. The septic tanks were provided with sludge drains, and advantage has been taken of times of high water in the creek to flush out the deposits so that the tanks have never required cleaning.

Prolonged Litigation

The sewage from the northwest portion of the city was long emptied without treatment into a creek on that side of the city. In 1895 a farmer above whose land this outlet was located began legal action against the city to secure damages



VIEWS OF SPRINKLING FILTER, SEDALIA, MO., SEWAGE TREATMENT PLANT.
Left: View Taken During Construction. Right: Distributing and Underdrainage System.

and prevent the pollution of the stream. From this time on the case was continually in the courts for over 20 years; the case was tried four times in lower courts and each time was appealed to the Supreme Court, by which it was remanded three times for new trial in the lower court; change of venue was also secured twice. One count was finally decided by the Supreme Court, but the second count never was settled. A few years ago the farmer who brought the suits died, and the estate made a proposition to the city to donate three acres of land on the farm to be used as a site for a modern sewage treatment plant, and agreed to dismiss the suit in the courts. The result of this proposal was that the city engaged engineers to design such a plant. It is probably safe to say that during the prolonged litigation in the courts the city spent one-third or more of what a treatment plant would have cost.

The district from which the sewage is treated in the northwest plant comprises practically all the commercial and industrial portion of the city, and a considerable portion of the residential portion, with an area of approximately 240 acres, most of which is closely built up.

The New Plant

The sewer system is a combined system receiving both sanitary and storm sewage. The dry weather flow was intercepted at the outlet of the brick sewer and carried on down the creek through a 24-in. pipe to the treatment plant. Weir measurement of the dry weather flow taken continuously for three days indicated an average flow of about 850,000 gals. per day, but a yearly average was estimated to be around 1,000,000 gals. per day. The plant was designed for a total capacity of 1,500,000 gals. per day in order to provide for the possible increase during a period of 10 to 15 years.

Since the final effluent was to be discharged into a small stream having very little flow during dry periods, the type of plant selected was such as to prevent unsightly deposits, pollution of stream by decomposing matter and injury of water for stock purposes. The plant as constructed consists of an interceptor and grit chamber, Imhoff tanks, sludge beds, dosing tank, and sprinkling filters.

Intercepting and Grit Chamber

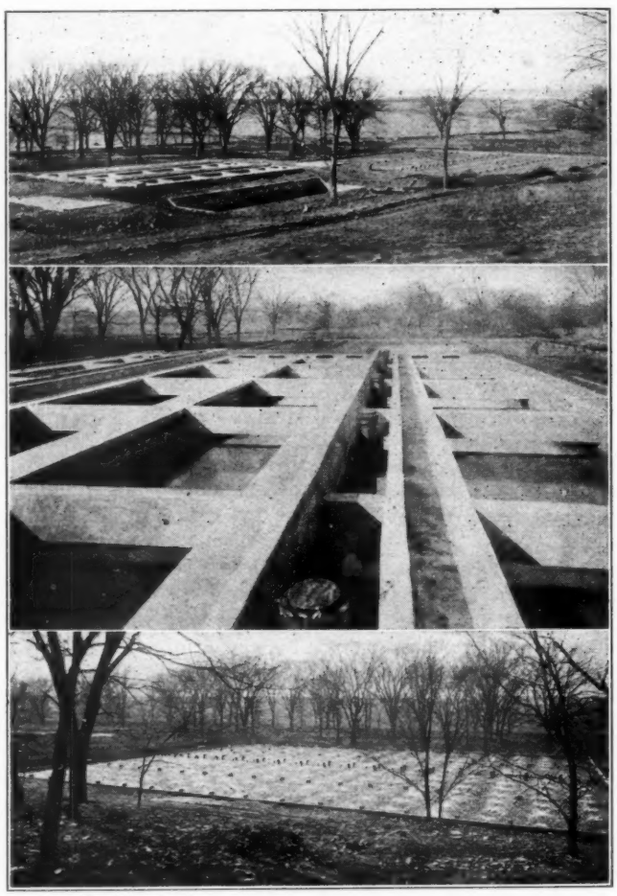
Since the sewer system is a combined system and the treatment plant is designed for the sanitary sewage only, a combined intercepting and grit chamber is provided, so that the operation of the plant will not be interfered with by a great inflow of storm water during rainy periods and by the collection of sand and gravel in the Imhoff tanks. The entrance chamber contains two weirs, so that when the flow exceeds the rated capacity of the plant the surplus will overflow the second weir and pass directly to the stream. The sewage passing the first weir enters a grit chamber 20 ft. long and 8 ft. 6 ins. wide, with hopper-shaped bottom, so that the velocity is reduced to approximately 1 ft. per second, allowing the heavier street washings to settle. These deposits can be periodically removed or flushed out into the by-pass. A bar screen with ½-in. openings is provided in the outlet from the grit chamber to intercept the largest floating and suspended matter.

The Imhoff Settling Tanks

The Imhoff tanks are rectangular in form and divided into two separate tanks, so that either one can be put out of use at will. Each tank is 73 ft. long, 25 ft. wide and 21 ft. 6 ins. deep from surface of sewage to bottom of sludge chamber. The capacity of the flowing-through chambers is designed for a 2-hour retention period on the basis of the average flow. Each tank has a bottom consisting of five hoppers, each 14 ft. square at the top, 2 ft. at the bottom and 3 ft. 6 ins. deep. The sludge chambers have a combined capacity of 15,220 cu. ft. figuring up to 1 ft. below the slot. The gas vent is formed by a continuation of the hopper walls and is 2 ft. wide and 3 ft. above the sewage level extending the entire length of the tank. Equalizing parts are provided across the gas vents at each end to prevent any tendency of fresh sewage stirring up digested sludge due to unequal flow and head on weirs.

The sewage enters the inlet channel at one end and flows over eight weirs 30 ins. wide into the tanks, and passes out over eight similar weirs of removable iron plates into the outlet channel. The inflow will be about 6 ins. deep, allowing floating material to pass, and when reversal of flow is desired the iron plates can be transferred from the outlet weirs to the opposite end and the sewage will then flow through channels around the outside of the tanks. Scum walls extending 18 ins. below the sewage surface are provided at each end of the tanks to retain floating matter.

Each sludge chamber is provided with an 8-in. cast iron sludge draw-off pipe, through which sludge is withdrawn under a hydrostatic head of 4 ft. 6 ins. below the sewage level. The base of this sludge pipe is enlarged by a 16x8-in. reducer



VIEWS OF SEWAGE TREATMENT WORKS AT SEDALIA, MO.

General View of Plant—Imhoff Settling Tanks—Sprinkling Filter in Operation.

and the top is carried up vertically to the top of the gas vent. Gate valves are provided on each sludge pipe just outside the Imhoff tanks, and the remainder of the lines is vitrified pipe.

Sludge Drying Beds

The sludge flows to two sludge drying beds, each 73 ft. long and 20 ft. wide, the inlet pipes being 18 ins. above the surface of the beds. These beds are located parallel to the Imhoff tanks, one on each side and 5 and 10 ft. away, respectively, and are inclosed in vertical concrete walls varying in height from 2 ft. 6 ins. to 9 ft. 6 ins. above the footings, to conform to the final fill around the plant. The filtering material consists of 6 ins. of sand over a layer of gravel varying in thickness up to 6 ins. over the top of the underdrains, which consist of three lines of 6-in. drain tile laid 6 ft. apart and draining into the

main by-pass around the plant. The bottom of the beds was graded so as to slope 6 ins. toward the drains. The capacity of the beds was proportioned on the basis of a four months' storage in the tanks, figuring .0035 cu. ft. sludge per capita per day for 10,000 population, and a depth of 18 ins. on the sludge beds.

Dosing Tank

The effluent from the Imhoff tanks flows through an 18-in. pipe to a covered tapered dosing tank, 15 ft. square on top and 9 ft. by 3 ft. at the bottom and 6 ft. 10 ins. deep inside. An 18-in. siphon with a drawing depth of 4 ft. 6 ins. is set in the floor of this tank and automatically discharges the contents of the tank to the amount of 7,000 gals. about every ten minutes through a 24-in. sewer, incased in concrete, to the sprinkling filters.

Sprinkling Filters

The sprinkling filters have an area of about 0.6 acre and are 184 ft. long and 146 ft. wide, the width being controlled by the topography of the ground. The filters are designed to operate at the rate of 2,500,000 gals. per day, with an average depth of rock of 5½ ft., and varying in size from 1 to 2½ ins. The limestone rock for the filters and also for concrete aggregate was obtained from a quarry in the hillside about 200 ft. away.

The floor of the filters is of plain concrete, 4 ins. thick, over which 6-in. split drain tile underdrains are laid 7½ ins. center to center and on a slope of 1:50 toward the two main drains. The walls of the filters are 6 ins. thick at the top, 8 ins. at the bottom and 6 ft. 6 ins. high, not designed to be self-supporting, but only to separate the earth and stone, hence requiring equal fill outside and inside during construction.

The main distributer is of 24-in. vitrified pipe, and the laterals of 8-in. vitrified pipe, both incased in concrete. Each lateral is controlled by an 8-in. gate valve near the main. Three-inch galvanized pipe is used for the risers and distribution is effected through 252 Taylor square spray sewage nozzles spaced 10 ft. centers. The main drains are of 15-in. split sewer pipe. The bed is ventilated by means of 8-in. sewer pipe risers, surmounted by one-quarter bends, there being 110 vents in all, partly over the box vent chamber at the upper ends of the lateral drains and partly over the main drain.

Provision is made for by-passing the entire plant or the filters only. Final discharge of the effluent from the plant is into the creek only a few feet from the filters. The total head from the invert of the sewer entering the intercepting chamber to the lower end of the main drain from the filters is 14 ft. 8 ins.

Personnel and Costs

The contract for the construction of the plant was let in November, 1916, to J. W. Menefee, of Sedalia, for $50,000, and the plant was completed in the fall of 1917. The plans were prepared by Burns & McDonnell, consulting engineers, Kansas City, Mo., who also drew the plans for the southeast plant; and the construction work was supervised by F. T. Leaming, city engineer, of Sedalia.

The average cost of the various parts of the plant per 1,000,000 gals. capacity was as follows:

Intercepting and grit chamber	$ 350.00
Imhoff tanks	10,600
Sludge beds	1,200
Dosing tank	650
Sprinkling filters	19,800
Piping	700

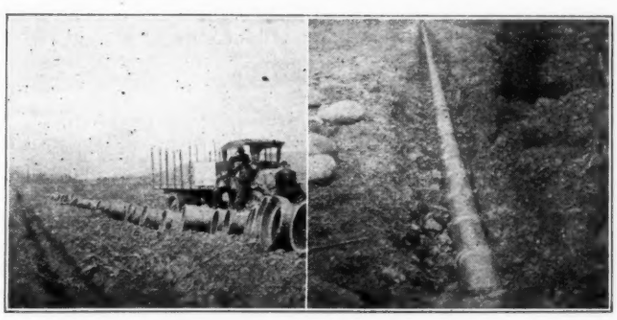
DRAINAGE AND IRRIGATION

The Use of Vitrified Clay Pipe for Irrigation Lines

By V. E. Piollet, Spokane, Wash.

Vitrified clay pipe is a suitable material to use for distributing the water in irrigation districts. A description of the metheds of manufacturing vitrified pipe is thought to be in order, as engineers, while of course familiar with its use, may not know just how it is made. Either fire clay or shale makes an excellent pipe when properly selected. Deposits of good shale or fire clay are not numerous. The clay is mined and delivered at the storage shed at the plant. From this shed it goes into revolving screen pans, which grind the clay, and it is then elevated into a bin. From this bin it goes to what is known as the "wet pans," where water is added. This process is known as tempering. Now it is again elevated to the press, which is a large cylinder with a plunger. The die is placed on the end of the cylinder with a former. The plunger is forced down by high-pressure steam, the bell is formed and then the former is released and the cylinder of pipe comes out of the die. The pipe is formed and pressed out under pressure, which insures a close, dense body, without voids.

The pipe is taken from the press and put on the drying floor, where heat is applied for several days, until practically all the moisture has left it; then it is set in a down-draft kiln and the heat gradually raised until it reaches the point of vitrification, which occurs just before the pipe would melt if one continued to raise the heat. Salt is then put on the fire, causing a vapor to form, which gathers on the pipe and makes the glaze. The heat is held until the pipe is thoroughly glazed, and then it is allowed to cool slowly to avoid cracking from too sudden change of temperature. After the kiln is cool, the pipe is taken from the kiln and loaded for shipment. Arriving at destination, the pipe is drawn and distributed along the ditch; motor trucks are much used for this purpose.



USING VITRIFIED CLAY PIPE IN IRRIGATION LINES. Motor Trucking the Pipe to the Trench—A Well Laid Line Ready for Backfilling.

Making Good Joints

To secure a well-laid pipe line, one must obtain, first, a good foundation; second, a straight, smooth interior, and third, a well-made joint. For the pipe foundation, make a space a little deeper where the bell or joint comes, so that the

pipe will rest on the solid ground its entire length. After the pipe is jointed, tamp carefully.

There are several methods of making a joint and a great deal of the success of the system will depend upon the care with which the joints are made. Cement or asphalt are generally used and good joints can be made with either. The best practice in making the joint is to use the "pouring method." The type of mold most generally used is composed of a series of overlapping sheet metal plates, strung on two steel cables of small diameter.

After observing all the usual precautions in the support and alignment of the pipe in the trench, the first two lengths of pipe are placed in the trench, with the spigot end of one thrust well into the socket of the other. The joints are caulked with oakum and the oakum compacted with proper tools all around the joint, to form a gasket and prevent the flow of the joint material into the interior of the pipe. The mold is dipped in oil to prevent the grout from adhering to it, then passed under and around the joint and clamped in such a position that a firm grip is taken on both pipes, with enough overlap on the socket to insure an even and maximum space for the joint material. The funnel, of course, should be on top. Sufficient molds must be provided for one day's work. Molds are clamped onto the entire number before any are poured. Cement for the joints should consist of one part by volume of Portland cement and one part clean, sharp sand of medium fineness, and mixed with sufficient water to give a consistency of thick cream.

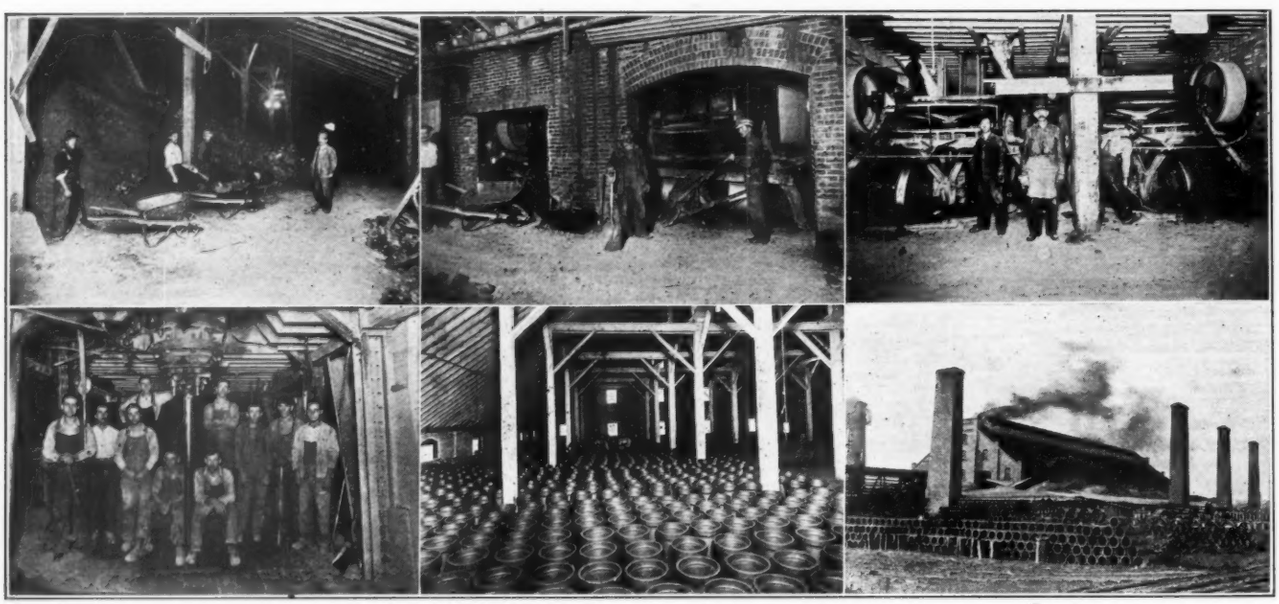
Molds are left in place from 12 to 24 hours, to permit the cement to take its initial set. The mold unclamps in such a manner as to split the funnel or hopper into two parts, leaving a protruding jet of surplus joint material, shaped like the funnel. Joints made by this method will cause practically no trouble, and when the line is put in operation, will not develop leaks.

Pipe should be laid deep enough so that it will not be disturbed in plowing and the water will not freeze, if, by accident, any is left in the pipe after the irrigation season is over.

Limiting Pressure

Vitrified pipe should never be used where high pressure is developed. While it will stand 35 to 40-ft. head, it is not practical, and it is recommended to limit the head to 12 to 15 ft. for sizes from 4 to 10-in. and to 8 to 10 ft. for 12 to 24-in. The engineer will so lay out the system that none of the pipe will be subject to a greater pressure than that just given. There are numerous methods of breaking the head. The most common of these is, where the pressure is equivalent to much over the head mentioned, to break it by constructing cut-offs or inserting a valve in the main supply pipe at about the point where the pressure should be broken, and then regulating the flow with this cut-off or valve. It is important that vent holes be provided to allow the air in the pipe lines to escape when the water is first turned on, to prevent "water hammer," which would rupture the pipe line.

If the contour of the tract to be irrigated is irregular or rolling, high-pressure pipe should be used to siphon the water over deep cuts. This pipe will not be as permanent as vitrified pipe, but the system can be so designed that only a small proportion of high-pressure pipe will be needed. The main trunk line will, of course, follow the highest ground. Valves or control chambers are placed along the trunk line where each lateral line connects. Other valves and weirs for measuring the water going to the sub-laterals that deliver water to each owner are built, tapping the laterals at the highest elevation on each individual's property.



VIEWS OF REPRESENTATIVE VITRIFIED CLAY PIPE FACTORY.
Top Row: Clay Storage Shed—Dry Pans—Wet Pans. Bottom Row: The Press—Drying Floor—Exterior View of Factory.

In extremely large irrigated districts the main trunk line can be constructed to carry any quantity of water by laying more than one line in the main trench. For instance, say the maximum amount of water needed is 40,408 gals. per minute and the fall is 1 ft. in 100 ft. It is found that a 30-in. vitrified pipe will carry 20,204 gals. per minute, 1-ft. fall in 100 ft., thus two 30-in. pipe lines will be needed. Sub-trunk lines would probably start with a 24-in. pipe and reduce down to 20-in. to 18-in. to 15-in. pipe. Laterals start with 12-in. and reduce to 10 to 8-in. pipe, and sub-laterals start with 6-in. and distribute with a 4-in. line.

Vitrified pipe has many advantages for irrigation. It is impervious to moisture, due to the density of body, vitrification and the glaze. It will not disintegrate, and vitrified pipe lasts for many decades. Its smooth glaze or glassy surface offers the minimum of friction and assures a maximum carrying capacity for a given diameter. Vitrified pipe is not adversely affected by alkali.

Most manufacturers have improved their pipe and are now furnishing what is known as the "deep and wide socket pipe," which is the same as the ordinary bell and spigot pipe, with

the exception that there is more annular space and a deeper bell, which naturally makes it easier to secure a strong and lasting joint. Both the spigot and bell are corrugated or scarified, offering an excellent surface for the cement to adhere and forming a key when filled with the cement.

Vitrified clay pipe is being used more and more for irrigation systems where permanency is desired. There are systems installed by the U. S. Reclamation Service that have been in use for 14 years, and they are as good now as on the day they were finished, and have cost practically nothing for upkeep in the meantime.

Results of the Irrigation Work of the U. S. Reclamation Service

In 1917 the 29,000 farmers on 1,000,000 acres of land reclaimed by the U. S. Reclamation Service, Department of the Interior, went over the top with a crop valued at $50,000,000.

The production capacity of the American desert after irrigation is emphasized when the results of the farmers of irrigated lands are compared with those of the humid states. The 1917 crop from reclaimed lands exceeds in total value by $11,000,000 all the crops of Maine, as shown by the census reports of 1909. It is greater by $7,000,000 than the combined crops of New Hampshire and Vermont, and only $4,436,000 less than the total crop values of Massachusetts and Connecticut.

$50 per Acre Gross Average of Irrigated Crops

The gross average of $50 per acre for crops grown on the government's irrigated farms is remarkable when compared with similar statistics for all farms in the United States, the average yields of which in 1909 were only $16.30 per acre. Such returns should at least allay the apprehension, if any now exists, that these farmers will not be able to return the investment of money which has been made by the Government in constructing the irrigation systems. On several of these projects a single crop will suffice to return the entire investment.

Present Status of the Reclamation Work

The summation of the activities of the Reclamation Service to date shows that work is under way on 30 projects, in 15 states. These projects embrace aproximately 3,112,655 acres, or 60,331 farms. Water is now available for 1,750,000 acres in 37,103 farms, and the construction of the necessary works to reclaim the balance is proceeding as rapidly as the limited funds will permit. As fast as water can be made available for the public lands in these projects, the settlers flock to them and the demands are usually in excess of the supply. Land hunger is increasing with the rapidly rising price of farm lands, and the better prices for farm products. In view of this condition and considering the imperative need of an enormous increase in food products, the importance of quickly extending the field of reclamation is obvious.

Resume of Engineering Works to Date

A brief resume of the engineering works to date is illuminating. Since the organization of the service in 1902 it has to its credit many notable achievements. Several of the structures are monumental in character and rank with the greatest engineering works of the world. The engineers of the service have successfully completed the highest masonry dam, the longest tunnel, and the largest reservoir for irrigation ever built. Across the desert they have extended a canal system 10,313 miles long, in which whole rivers are carried and turned upon the land. The huge reservoirs in the mountains, with a combined capacity of 9,000,000 acre-feet, hold back the floods of many streams. Twenty-six miles of tunnels penetrate the mountains, and through two of these, two rivers are carried outside of their own drainage basins. The surplus and waste waters are disposed of by means of drains and ditches having a length of 1,247 miles.

The volume of the dams is 13,258,729 cu. yds., and the excavations of rock and earth for canals and foundations reach the great total of 154,016,449 cu. yds., or about 60 per cent. of the total yardage of the Panama Canal.

In the construction of the several irrigation systems it was necessary to dig 391 wells having a total depth of more than 6½ miles. More than 13,000 bridges and culverts of steel, concrete and wood were constructed, which end to end would extend 74 miles. Canal structures of wood and concrete number more than 85,000. Pipe lines and flumes long enough to reach from New York to Washington and back again are now in place.

The Service has built and operated 82 miles of standard gage railway, 2,871 miles of telephone, and 442 miles of transmission lines. In order to begin construction on many of the important works it was necessary to build an aggregate of 932 miles of wagon roads.

The power plants of the Service have developed 48,093 h. p., which is utilized in construction and leased to many municipalities and individuals. More than 1,200 buildings of all sorts have been erected for the accommodation of the employes and for other purposes. During the period of engineering work the Service has laid out and established eleven town-sites, several of which are today thriving business centers.

BRIDGES AND BUILDINGS

Cost of Painting Steel Highway Bridges in Iowa

By C. E. Smith, County Engineer Henry County, Mt. Pleasant, Iowa

A painting crew organization for the purpose of keeping the old steel bridges in the county properly painted has been in existence in Henry county, Iowa, for several years. A summary statement of the cost of doing this work in 1917, and a brief description of the crew, are here given.

Crew

The crew consists of a foreman and one or more laborers, who are provided with all necessary paint, brushes and tackle, and a team and wagon for transportation purposes. One of the laborers acts as teamster. The prevailing wage last year for these crews was: Foreman, 37½c per hour; laborers, 27½c per hour; team and wagon without driver, 47½c per hour. These crews were operated during the months of May and June.

Painting

The paint used was C. R. Cook's sublimed blue lead, white lead used on hand rails and end posts. All exposed surfaces were cleaned with steel wire brushes and given one coat of field paint.

Costs

Detailed costs on each bridge are available, but only the summary data for the entire year are presented here. The

bridges painted were principally I-beam spans and pony truss spans with wood and steel joists.

Total length of span painted	2,485 ft.
Number of gallons of paint used	271
Cost of paint per gallon	$ 1.80
Total paint cost	488.70
Total labor cost	695.53
Cost of brushes	20.00
Total cost of season's work	1,184.23
No. lineal ft. of span per gal. of paint	9.17
Cost per lineal foot of span	4.76

How Motor Trucks Saved $15,000 for Contractor on Building Excavation

In excavating for the construction of one unit of the Henry Ford Hospital in Detroit the contractor removed 16,000 cu. yds. of material at 45 cents per yard, by the aid of a motor truck, and this unit cost using teams would have been $1.33. Thus the saving due to motor haulage on this job amounted to about $15,000.

The Detroit Excavating Company were contractors on this job with "Con" Devers of the firm, in direct charge. He has had charge of the work of excavating for many of the large buildings erected in Detroit in recent years. This company has been operating in Detroit long enough to be thoroughly conversant with the cost of both horse and motor haulage. At present they can get a one-horse team with driver, capable of hauling 2 cu. yds. at a load, for $8 per day. They know that for $25 per day they can operate a motor truck on this class of work with a capacity of 5 cu. yds. per load.

In figuring on the Ford Hospital job they found that their nearest dumping place for the excavated material was three miles distant from the building site. They knew that horses could make a 6-mile round trip 3 times daily while motor trucks could make ten 6-mile round trips daily, so they decided in favor of motor haulage.

The main excavation was 620 ft. long with a T at either end 200 ft. long. In addition to this there were several 18 and 30 ft. extensions. With an average depth of 5 ft., this made 16,000 cu. ft. to be excavated.

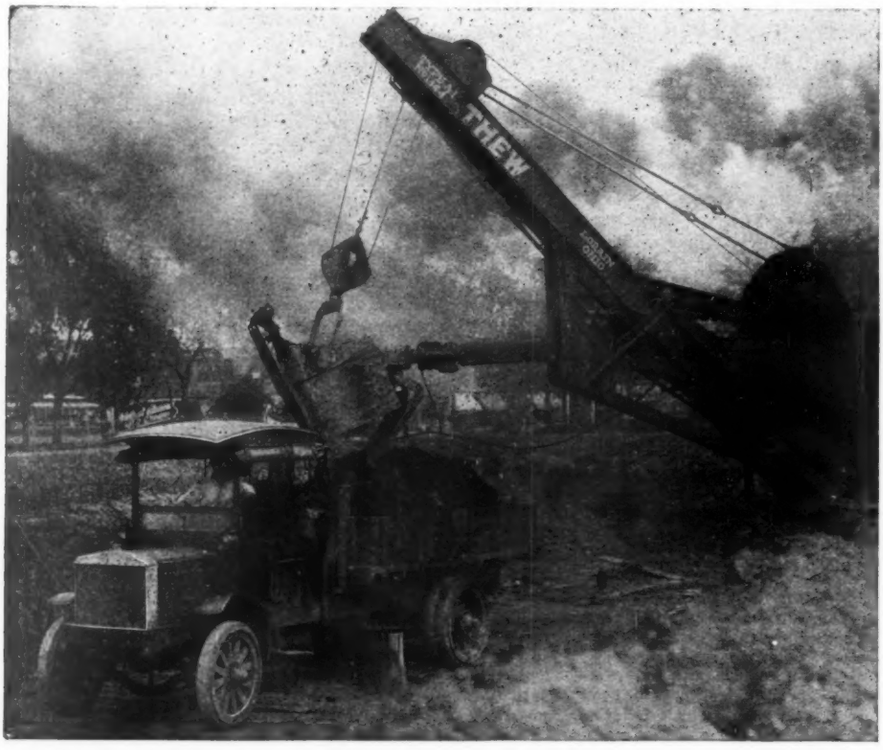
Most of this dirt had been at one time filled in and was therefore uneven strata and held considerable moisture. It was necessary to build a plank roadway the whole length of the excavation, owing to the wet condition of the dirt, to keep the heavy motor trucks from mireing. The plank alone for this roadway cost over $800.

The comparative cost of team and truck haulage figured out as follows:

Length of haul, 6 miles.

One Team

Size of load (cu. yds.)	2
Number of trips per day	3
Total yards per day	6
Cost of hauling 6 yds	$8.00
Cost per yard with horses	1.33



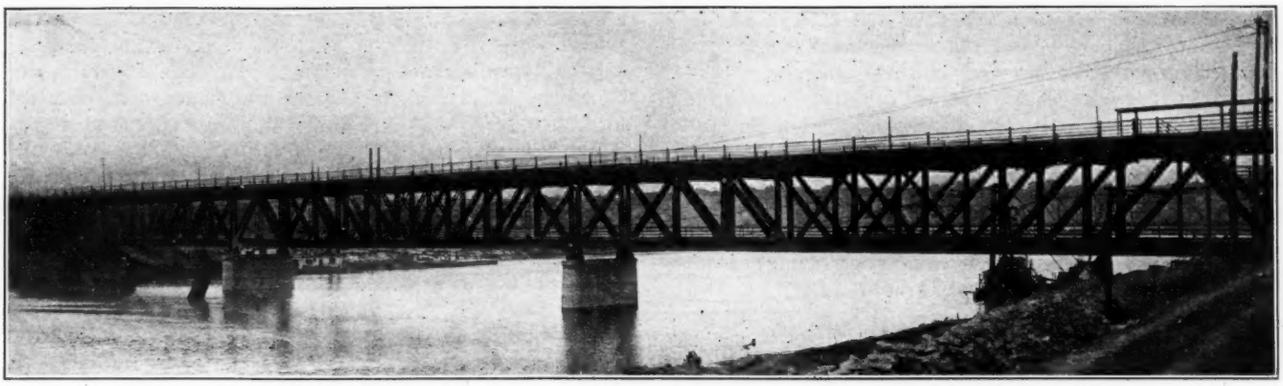
FEDERAL TRUCK HAULING EXCAVATED MATERIAL, HENRY FORD HOSPITAL CONSTRUCTION, DETROIT, MICH.

One Truck

Size of load (cu. yds.)	5.5
Number of trips per day	10
Total yards per day	55
Cost of hauling 55 yds	$25.00
Cost per yard with trucks	.45

Several makes of trucks were used on this work, among them several Federals. The two views herewith show a Thew shovel loading the trucks, and a loaded Federal negotiating the steep excavation grade. This grade was about 20 per cent.

"We were the first company in Detroit to use trucks for removing the earth from excavations," said "Con" Devers, "and we do not know what we would do without them now. On this job alone, it would have made our price nearly $15,000 more if we would have had to use horses. It seems like only yesterday when we had no other means of hauling except the horse, and we wonder now how we ever got along, but at any rate, we could not work with the speed and certainly that we can with trucks."



VIEW OF THREE-SPAN, DOUBLE DECK BRIDGE ACROSS KANSAS RIVER, AT KANSAS CITY, KANS.

Wyandotte County, Kansas, Builds Large Double-Deck Steel and Concrete Bridge

By F. W. Epps, Bridge Engineer, Kansas Highway Commission, Topeka, Kans.

The bridge recently built by Wyandotte county, Kansas, herewith illustrated, consists of three 250-ft. double-deck spans across the Kansas (Kaw) river at Kansas City, Kans. The lower deck accommodates trucks and passenger traffic and is level with the ground at both ends of the bridge. The upper deck accommodates lighter traffic and two street car lines, which run out onto a viaduct 2,000 ft. long on either side of the river.

The lengths of the spans were determined by the requirements of the Kaw Valley Drainage Board, which place the harbor lines 734 ft. apart and allow only two piers between these lines. The trusses are riveted at all points, the ends being carried on pins supported on heavy steel shoes or rockers. The decks are of concrete covered by paving.

The concrete viaduct work was designed along as simple lines as possible, no attempt at ornamentation being made except such as could be added without increasing the cost. All corners are rounded off and columns are built in the form of a cross, which adds somewhat to the beauty of the viaduct. No surface finish was used on the concrete after the forms were removed, but as these consisted of 2-in. tongue-and-groove lumber, the surface was left fairly smooth.

The total cost of the structure was about $850,000, of which $320,000 was spent on the bridge across the river, $168,000 on the east approach, $112,000 on 700 ft. of the west approach and $250,000 on the remainder of the west approach. This last part was paid for jointly by the city of Kansas City, Kans., and the railroads operating under this portion. The balance of the structure was paid for by the county of Wyandotte.

The bridge and viaduct approaches were designed by Harrington, Howard & Ash, consulting engineers, Kansas City, Mo.

FROM WORKERS IN FIELD AND OFFICE

Features of Proposed Sewerage Works for St. Augustine, Florida

To the Editor: It was with interest that I read the article in your July issue, on page 17, entitled, "Features of Proposed Sewerage Works for St. Augustine, Fla."

I was city engineer of St. Augustine, Fla., when this report was submitted with their proposed plan. The plan they submitted was not approved, and in my opinion it would be a serious mistake to adopt the plan that was prepared by Alvord & Burdick.

The portion of your article that refers to the point that we differ on is found in the paragraph at the bottom of the first column, on the page mentioned. They say it is impossible to sewer the central part of the city by gravity, and accordingly three automatically controlled, electrically operated pumping stations will be required in that area.

The city can be sewered by gravity and I have prepared a plan that shows how it can be done.

The city of St. Augustine is situated on a peninsula, lying between two rivers. The average width of the city is about 4,000 ft. The portion of the city that Alvord & Burdick say cannot be sewered except by pumping has an elevation of 6.5 ft. above mean tide. They contend and planned that the minimum grade for 8-in. terra cotta pipe should be 0.25 ft. fall per 100 ft. I agree with them in this. If 8-in. pipe should be used for the shortest distance to the central part of the city, a distance of approximately 2,200 lin.ft., it would require a total fall of 5.5 ft. This would not leave enough cover, and the pipe would hardly give the necessary fall for the house connections. This is the reason why they recommended the use of pumping plants.

I am proposing to use 10-in. terra cotta pipe, laid on a 0.20 ft. fall per 100 ft., and cut out the pumping plants. There is not enough sewage to make the pipe flow two-thirds full, but I have proposed to overcome this by sinking five artesian wells. Artesian wells can be sunk anywhere, and the water will flow up to an elevation of over 20 ft. above the ground. A flow of 300 gals. per minute is easily secured.

I will secure for the distance mentioned above a fall of 4.40 ft., which will give me the same elevation as proposed by Alvord & Burdick at the head end of the line. By my plan the cost of pumping the sewage is eliminated and there will be a considerable saving by cutting out the plants. The substitution of 10-in. pipe in place of 8-in. pipe and the sinking of the wells will cost about half what the pumping plants would cost.

It is not often that one of us little engineers will buck up against the big fellows, but I feel that I have them bested, and I am going to save the taxpayers of St. Augustine thousands of dollars.

Mr. Henderson, mentioned in your article, was city engineer at one time, but not at the time when the report was submitted. I am at the present time assistant state highway engineer, in charge of the work in five counties, and the intentions of the city authorities of St. Augustine, Fla., are that as soon as the war is over I am to go back to St. Augustine and put in a sewer system as planned by me.

Very truly yours,

Holts, Fla., July 7, 1918. P. G. Ekman, C. E.

(Our correspondent's letter was brought to the attention of Alvord & Burdick, and their reply follows.—Editor.)

To the Editor: We thank you for the opportunity of replying to Mr. Ekman's letter re the proposed sewerage system for St. Augustine, Fla.

We will take up the items mentioned by Mr. Ekman in the order in which they are brought up in his letter.

First—Mr. Ekman states that the portion of the city which we have proposed to serve by pumping has an "elevation of 6½ ft. above mean tide," and, further, that the average width of the city is about 4,000 ft., making a distance something over 2,000 ft. to the nearest outfall. This statement, in so far as it refers to elevation, is in error. The following street intersections are in approximately the center of the city and immediately adjacent to the Ponce de Leon and the Alcazar Hotels:

Intersection.	Elevation above mean tide.
Cordova and Savilla	5.1
Cordova and King	6.1
Cordova and Palm Row	5.5
Granada and King	5.7
Granada and De Soto	4.9
Granada and Cedar	5.0
Treasury and Spanish	4.5

The average elevation of these intersections (which are in the heart of the city and of the district from which we planned to pump the sewage) is only about 5¼ ft. above mean tide.

Second—Mr. Ekman proposes to use 10-in. sewers instead of 8-in., on account of the fact that a smaller minimum grade may be used for the larger sized sewers. He loses sight of the fact that for very small flows, such as will take place in the St. Augustine sewers, increasing the size of the sewers is a step in the wrong direction, as the proportional velocity for small quantities of flow in the 10-in. sewers at a .2 per cent. grade is less than in the 8-in. at a .25 per cent. grade, and, accordingly, the liability to clogging is increased. If pumping is used, the 8-in. sewers can in most cases be laid at steeper grades and less flush tanks built.

Third—It is absolutely impracticable to use grades as low as .2 of a foot per 100 ft. for 10-in. pipe without the installation of flush tanks. The system proposed by Mr. Ekman will require approximately 25 flush tanks over those outlined in our report, which will cost at the present time in excess of $2,000. He proposes to furnish the water for flushing by sinking five artesian wells, but loses sight of the fact that additional flush tanks cannot be served by five wells without the installation of a water distribution system between the wells and the several flush tanks. This will necessitate an expenditure of not less than $2,000 per mile at the present time, and several miles will be required.

Fourth—The substitution of 10-in. pipe for 8-in. in order to use the flatter grade, as proposed by Mr. Ekman, would incur an additional expenditure of about $750 per mile of sewer. The 8½ miles of low-level sewers, therefore, if changed from 8-in. to 10-in., would cost an additional amount of $6,500 above that estimated—an amount in itself only $2,500 less than the cost of constructing the pumping stations as recommended in our report.

Fifth—We have gone into the St. Augustine matter fully and are convinced that the most practical method of sewering the central part of St. Augustine, which lies at an elevation of only 5¼ ft. above mean tide and approximately 2,000 ft. away from the water front, is by the installation of automatically controlled, electrically operated pumping stations, as outlined in our report.

Your article, July issue, was correct in stating that Mr. Henderson was the city engineer of St. Augustine, as he held that position for about two years, and was acting in that capacity during the time our report was prepared. Mr. Henderson resigned shortly before our report was submitted.

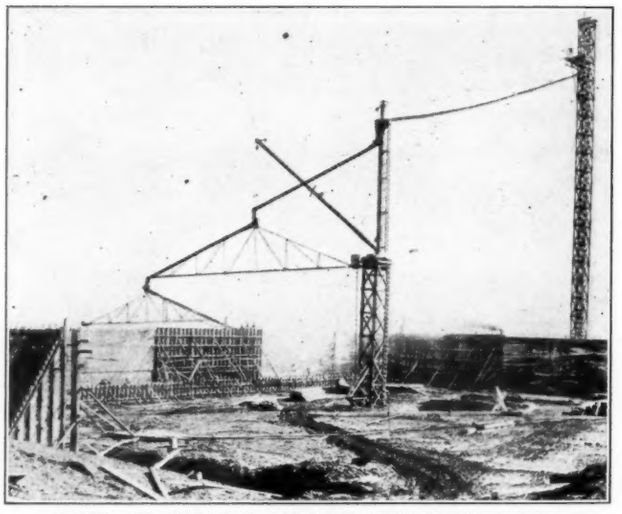
Very truly yours,

Alvord & Burdick,
By L. R. Howson,
Principal Assistant Engineer.

Chicago, Ill., July 11, 1918.

Concreting the East St. Louis & Interurban Water Company's Reservoir

To the Editor: The inside measurements of the new reservoir of the East St. Louis & Interurban Water Company, at East St. Louis, Ill., are 196x220 ft. The walls are 23 ft. high. It was necessary that the walls be poured first, after which a 5-in. layer of concrete was placed over the bottom of the basin in alternate squares. After a layer of asphalt water-proofing had been placed on the first layer of concrete, a second 4-in. layer of concrete was poured. The concreting equipment here illustrated eliminated all cumbersome floor tripods and reduced operating costs and time to a minimum. The method of construction demanded that concrete be placed at widely separated points at different times, so flexibility of concreting equipment was requisite.



VIEW OF SPECIAL INSLEY CONCRETING EQUIPMENT EMPLOYED ON CONSTRUCTION OF NEW RESERVOIR FOR EAST ST. LOUIS & INTERURBAN WATER COMPANY, EAST ST. LOUIS, ILL.

After a comprehensive investigation covering the merits of the different possible means of handling the job, the American Construction and Securities Company, the contractors, decided upon the installation designed for their consideration, which is clearly illustrated by the accompanying half-tone.

A tower approximately 140 ft. high was erected outside of the reservoir at a point where it was convenient to assemble the mixing plant and the necessary raw materials. A guy derrick, supported on a tower approximately 50 ft. high, was erected at a central point inside of the work. The guy derrick carried a mast hopper of special design, which both slides and rotates on the derrick mast and 150 ft. of chuting, 100 ft. of which was of the special Insley double counterweight design.

Concrete was hoisted in the main tower and chuted into the mast hopper by means of the continuous line chutes illustrated, and from the mast hopper was chuted into place by means of the derrick supported chuting. The fact that the mast hopper could be raised and lowered on the derrick mast made it possible to raise or lower the entire chute line, this being done in such a manner as always to maintain the correct slope of chutes while pouring the concrete at different elevations.

While the mast hopper and derrick-supported chute arrangement is novel, the real success of the installation is attributable to the double counterweight chutes. Through the employment of these chutes 100 ft. of chuting is provided which is entirely self-supported from the derrick, and no fixed overhead or ground supports at intermediate points were required for chute supports. The installation was therefore absolutely flexible in that the pouring end of the chutes could be shifted to any point of the work in a few moments' time; its adoption resulted in the pouring of the concrete with maximum efficiency—that is, in minimum time and with minimum labor—by equipment which involved but a reasonable capital expenditure.

Very truly yours,

Indianapolis, Ind. CARL S. WAGNER.

Sulphuric Acid from Nitre Cake

To the Editor: In rereading my article on "The Development of Sewage Treatment," I note an inadvertent error on page 248 of MUNICIPAL ENGINEERING for June, where, in referring to the Miles process, the text says, "By the use of sulphur dioxide, which may be obtained from nitre cake." This should read, "By the use of sulphur dioxide or *sulphuric acid*, which may be obtained from nitre cake," sulphur dioxide being obtained by burning sulphur or pyrites. Nitre cake at present is more available, as it is a by-product in the manufacture of explosives.

Very truly yours,

KENNETH ALLEN,

New York, N. Y. Sanitary Engineer.

Successful Use of Portable Asphalt Plant

To the Editor: We had under operation one of the 1,250-yd., 3-unit Cummer portable asphalt plants at Atlantic City last year, and found that this type of plant is very efficient and economical and will do all that the makers guarantee, and even more if it is properly handled. We have laid as high as 1,600 sq. yds. of 1½-in. surface with this plant in 9 hours; also, 1,500 to 2,000 sq. yds. of 1½-in. binder in 9 hours.

The plant, if properly equipped with gravity asphalt feed for conveying the hot asphalt to the mixer, can be operated with less labor than any plant we have ever used. The capacity of an asphalt plant depends upon the amount of dry material that the drum will furnish to the mixer, and the type of drum that is used on this plant has ample capacity to keep the mixer running steadily without delay. It handles wet and frozen materials as well as some of the larger railroad plants. This type of plant will keep a good sized grading and concrete gang busy on the street to keep out of its way.

Very truly yours,

WARNER-QUINLAN ASPHALT CO.,

Buffalo, N. Y. By PERRY G. HYDE, Supt.

Omaha Considering Municipal Ownership of Gas Plant

To the Editor: The city of Omaha contemplates municipal ownership of the gas plant. A condemnation court has been appointed to hear values of the property and the city of Omaha has retained Burns & McDonnell, consulting engineers, to make an inventory and appraisal of the entire property, to be presented before the condemnation court. A franchise of the present plant expires in the near future, and it is expected to have the appraisal presented the condemnation court before the expiration of the franchise.

This is of interest, inasmuch as Omaha is the largest city in the United States to take definite steps toward municipal ownership of the gas plant. Richmond, Va., and Duluth, Minn., are two of the largest cities now having municipal ownership of this type of public utility.

Omaha is encouraged toward such ownership from the success of the last six years with the municipal ownership of the water works. The city has reduced the rates about 60 per cent and is enjoying excellent service. The city of Omaha has now under construction a municipally owned ice plant, to be operated in conjunction with the water works plant.

Very truly yours,

BURNS & MCDONNELL,

Kansas City, Mo. By R. E. MCDONNELL.

GENERAL ARTICLES

Division of Engineering Established by United States Employment Service

Of special interest to technical men is the announcement of the recent establishment of the Division of Engineering, United States Employment Service, at 29 South La Salle street, Chicago. The principal purpose of this new department is to conserve the services of technical men and to make them available for military and industrial needs. This plan is to be accomplshed by means of registering, classifying and distributing technical men, and through an intimate consideration of their interests. Men will be placed, as a result, according to their training, experience and ability.

In view of the growing importance of the engineer and the technical man in the present war, the plans of the Division of Engineering represent great sociological and national values. The engineer is one of the most powerful forces in the development of war apparatus, cantonment sanitation and army transportation. His accomplishments are many and varied. To use his services economically is a patriotic measure.

Registration

In order to accomplish its great work, the Division of Engineering will register all technical men as soon as possible. Those desiring to register for emergency government work or for permanent advancement in positions meeting their qualifications, are urged to apply at once for blanks to the office of the Division of Engineering, 29 South La Salle street, Chicago.

The Director

A. H. Krom, who was recently appointed Director of Engineering, United States Employment Service, is especially well fitted for his new work. As former secretary of the American Association of Engineers he made the affairs of

technical men his principal interest and has gained a thorough knowledge of their affairs, their accomplishments and their ideals. He has been untiring in his efforts to gain deserved recognition for engineering as a profession, and has been eager to give the public a proper understanding of engineering activities. He is a graduate of the School of Engineering of Purdue University. He has recently acted as a recruiting agent for the government and has lectured extensively throughout the country in the interests of the war and its relation to technical men.

A. KROM.
Director of Engineering, U. S. Employment Service.

Advantages Gained by the Contractor in Employing a Consulting Engineer

By Ray S. Blinn, First Assistant Engineer, U. S. A. Ordnance Department, Camp Perry Proving Grounds, Box 308, Port Clinton, Ohio

During the last ten years I have noticed an increasing demand for engineers to act as advisers to contractors. During that period the writer has had his share of contractor clients.

The fact is that the contractor who worries along without expert advice cripples his actions to a large extent. He should at least retain an engineer if it is only for the reason naively expressed by one of my clients, who said: "I just got to have some one to talk over my plans with." In that casual remark lies a goodly amount of the reliance and confidence that an engineer can give the manager at times when decisions are being reached. This is really the basic idea in the employment of engineers by contractors. Many contractors are pretty good "deciders" themselves, but they need the backing of technical knowledge.

The Engineer's Function Is to Give Advice

The consulting engineer, however, should be the adviser, and not the judge, in money matters. The financial whys and wherefores are strictly the province of the man who has his money invested. The consulting engineer can easily become a nuisance when he oversteps his duties as adviser to insist on methods that might cause financial embarrassment to the contractor.

But when, in the flurry of the work, there are tables of costs to be made out, no amount of experience or intuitive judgment on the part of the contractor can displace the consulting engineer, who can then be of unlimited service to the contractor.

Typical Points on Which Engineer Advises Contractor

In my experience as a contractor's adviser I have encountered such problems as these:

1. Knowing the character and amount of excavation and distance to spoilbanks, one near involving cost of ground and one farther away involving pay salvage, which one to choose and what method to employ without buying additional equipment.
2. The right amount to invest in machinery, taking into account the time of completion and the probable skilled and unskilled men obtainable.
3. The kind of equipment justifiable, considering the total amount of work to do, depreciation and salvage.
4. The right number of men to be assigned to certain parts for economy.
5. To what extent it is necessary to distribute costs.

Limitations of Cost Analysis

This last problem may cause some surprise to efficiency experts as to why any question should be raised as to limiting the inquiry into cost accounting, but the fact is that too much demand upon foremen to separate time or upon material clerks to divide bills will cause undue irritation. This will interfere with the prosecution of the work at any time, and, in these times of varying rates, will lead to no real information. A method of simple cost distribution is entirely within the province of a consulting engineer rather than the office man.

Upon a recent job, representing eight paving contracts, it was considered more essential to divide between labor, material and overhead between the classes of work rather than upon the separate contracts, which would involve merely a divisional distribution.

The Engineer as an Executive

For large companies the function of the consulting engineer may properly be enlarged by his taking the part of the executive. There is no experienced man better able to make good as an executive than a trained engineer, and, on the other hand, being an executive is good training for the engineer, for no man can be a successful adviser who cannot manage a business. I once heard the efficiency expert of the largest manufacturing company in Columbus say that the best quality in any man was "adaptability." The older I grow the more this thought strikes me as being proper. To be able to throw aside preconceived notions and get better ones is only a sign of advancement. In the alliance between the consulting engineer and the hard-headed contractor each gets a better viewpoint of his own worth and limitations. Both the contractor who insists upon doing it the same old way and the engineer who always wants to try something new lack adaptability, and each is handicapped just that much. The sooner each realizes the other's worth the better for both. Like Lincoln's "rat hole," this is worth looking into.

Reinforced Concrete Ships as a Possible Solution of Our Shipping Problem

By Earle P. Press, President of the Concrete Reinforcing and Engineering Company, Cleveland, Ohio

It is interesting to note the rapidity of the growth in general of concrete ship construction caused by the stress of the times. Under ordinary conditions there may have been considerable interest, but the actual progress would have been very slow.

To those of us who are commercially interested and closely following this progress it is surprising to find such a large number of projects, with the result that concrete ship building may almost be classed as an industry. This class of work has especially appealed to contractors who are equipped to undertake concrete construction, but who have very little work on hand of this character, due to present conditions. Many contractors are investigating the opportunity offered.

It has been clearly shown that our transportation facilities have been inadequate, and it is really surprising to us now to

realize what little use we have made of our inland water facilities. In all localities near navigable streams or the great lakes existing transportation companies, or companies about to be formed, appear as live prospects for this business.

In many instances concrete barges can be used to very good advantage. Reinforced concrete barges are comparatively simple in design and easy to build.

Quite a number of concrete ships are being built at this time, most notable of which is the Faith, which was launched in March near San Francisco. We are all familiar, through general publicity, with this launching. However, the mere launching does not indicate finally whether ships of reinforced concrete are successful or not. Actual experience, under heavy sea conditions, is necessary to prove concrete ships successful for ocean service.

It has been definitely pointed out by the Emergency Fleet Corporation that the present emergency calls for ships of large tonnage rather than a larger number of small ships. This policy is responsible for the practical abandonment of the construction of wooden ships.

Unless we can build concrete ships of practically 10,000 tons in a practical manner, reinforced concrete ships are to have very little effect on the shipping problem during the present emergency. It is to be regretted that most of the experimental work in connection with reinforced concrete ships, up to the present date, has been on ships of about 3,500 tons capacity, which will be too small to be decidedly helpful.

It is not necessary for contractors to apply their efforts to ships of the larger capacity, as it is unwise to build ocean-going ships until our present concrete ships have been subjected to heavy seas. There is a large field, however, for the contractor in smaller ships and barges, which are in no way subjected to the same conditions which confront the ocean-going ship of large size.

It is to be hoped that a larger number of contractors will have the initiative to enter the new industry of reinforced concrete ships.

An Erasing Machine for the Drafting Room

Engineers and others who have observed how easy it is to spoil a costly tracing by rubbing a hole through it with an ink eraser in the hands of a careless operator, will be interested to learn of the new erasing machine that has been placed on the market by Kolesch & Co., 138 Fulton St., New York.

The machine is herewith illustrated. It is driven by a variable speed motor which can be attached to any electric light socket and operates on either direct or alternating current. The flexible shaft which connects the eraser and the motor is 3 ft. long and is attached to a counter-shaft which is driven by a belt, as illustrated.

DRAFTSMAN'S MOTOR-OPERATED ERASING MACHINE.

These erasing machines are sent on 10 days' trial. Of course the circular erasers on which the wear occurs are easily and cheaply replaceable.

Good Practice in Business and Residential Electric Street Lighting

By H. F. Bloomquist, City Engineer, Mankato, Minn.

The importance of attaining a high efficiency in a street lighting system is emphasized by the fact that many municipalities expend as much money for street lighting as they do for maintaining their streets in repair, and all know that street repair work is a large and important item.

Classes of Street Lighting

The following classes of street lighting should be studied separately, namely:

A. Business street lighting.
B. Resident street lighting.
C. Parkway lighting.

In this discussion only electric lighting is considered as it is the only kind used in new systems at this time.

Principles and Features Common to all Systems.

In designing new systems of lighting, special study should be made of the surroundings, the classification and purpose of the lighting. There are, however, some principles and general features that are common to all systems. Among these are:

1. Transmission of energy.
2. Types of lamps used.
3. Placing of lamp units on posts, brackets or suspended.
4. Cost of installation and operation compared to the results obtained.
5. Diffusion of light so as to prevent glare.

Business Street Lighting

The present tendency in business street lighting is to attain a fairly well intensified light from lamps placed on posts on the curbs on both sides of the street. The spacing of posts should not be more than 100 ft. for good distribution. In this class it is desired to illuminate the fronts of buildings as well as the street, and to attain good results a closer spacing with less intense light units is desirable. For curb lights of this class it is necessary to diffuse the light by the use of frosted, opalescent or refracting globes which absorb a certain amount of the light, usually from 10 to 30 per cent, according to the density of globes used and the intensity of the light. To avoid glare, the lamps should be placed about 15 feet above the curb.

Residential Street Lighting

In resident lighting the problem of shade trees enters very strongly as a factor in determining the location of the lights. For lighting the driveway either the bracket or suspended lamp is very efficient, but their appearances are not in harmony with the surroundings and up to date tendency. The shade trees will also prevent the greater part of such light from properly lighting the sidewalks, and dark places along the street. Small units of post light about 10 ft. above the curbs make an attractive method of placing residence street lights if the lower branches of the shade trees are trimmed high. Special attention should be paid to the trimming of shade trees with this point in view. It not only aids the solution of the lighting problem, but also adds to the attractiveness of the street.

Post Lighting

The installation cost of the post lighting is very much more than that of bracket or suspended lamp system, and may not be warranted in all cases.

Parkway lighting may be treated in a manner similar to residential street lighting, with greater spacing of lamps.

In all post systems it is necessary to use underground wire systems, which adds materially to the cost of installation. For underground wiring two general methods are used: the conduit system and the ground or park cable system. For the business section of a city, the writer

strongly recommends the conduit system because of the liability of injury to park cables where excavations are made. Where a conduit system is used it is a comparatively easy matter to take out a section of cable where trouble occurs and draw in another section, but where a park cable is causing trouble from injury or other reasons it is often a long and difficult job to locate and remedy it especially if laid under pavements.

Catalog Reviews

MOTOR ROAD ROLLERS.—Issued by Austin Manufacturing Co., Chicago. 9x12 ins., 64 pages. Illustrates and describes Austin motor road rollers operating on gasoline, kerosene and distillate. Features rollers of macadam and tandem types and gives descriptions of the various machines for road and street scarifying. Designated as Catalog E. Shows numerous interesting and instructive views of this equipment in operation and gives many letters of indorsement received from contractors.

KENTUCKY ROCK ASPHALT.—3¼x5½-in. pamphlet issued by Kentucky Rock Asphalt Co., Louisville, Ky. States advantages of this type of rock surfacing.

CONCRETE MACHINERY.—Issued by the Lakewood Engineering Co., Cleveland, Ohio. 8½x11 ins., 8 pages. Bulletin No. 32. Illustrates and describes the Lakewood Universal mixer.

KISSEL TRUCKS.—Issued by Kissel Motor Car Co., Hartford, Wis. 9x11½ ins., 10 pages. Illustrates and describes the four new Kissel truck models.

ROAD AND HIGHWAY MACHINERY.—Issued by Kinney Manufacturing Co., Boston, Mass. 6x9 ins. Comprises Bulletins A and B, issued in pamphlet form by this company. Pertains to equipment especially designed for handling bituminous material or other similar products used in the construction and maintenance of roads and pavements, with special reference to heaters and pressure distributors, asphalt and tar pumps, steam and gasoline engine driven loading pumps, hand spraying pumps and nozzles, street flushing machines, heating kettles and storage tanks.

MOTOR TRUCK TRAILERS.—Circular issued by Detroit Trailer Co., Inc., Detroit, Mich. Relates to Model D trailer, giving some of the design and construction features, and a brief description, with illustrations of this trailer.

HYDRAULIC MACHINERY.—Issued by Allis-Chalmers Co., Milwaukee, Wis. Bulletin No. 1636-A. 8x10½ ins., 56 pages. Illustrates and describes the full line of hydro-electric power plant machinery and equipment manufactured by this company. Shows drawings of installation details. Gives suggestions on the selection of the correct type of unit. Gives test data and suggestions on the reconstruction of old plants.

SEWAGE DISPOSAL.—Electro-Chemistry Applied to Sewage Disposal, by F. N. Moerk. Copyright by C. P. Landreth, Philadelphia. 6x9 ins., 84 pages. Contains 13 chapters relating to the Bio-chemical Methods of Sewage Disposal, Chlorination, History of Direct Electrolysis of Sewage, The Direct Oxidation Process, Apparatus and Appurtenances of the Direct Oxidation Process, Operation, Results Obtained in Practice, Sludge, Substantiation of the Direct Oxidation Process, Super-Oxidation, Engineering Data, Resume of the Direct Oxidation Process, and Principles of Electro-Chemistry.

CREOSOTED WOOD BLOCK FACTORY FLOORS.—By Lambert T. Ericson, contracting engineer. Issued by Jennison-Wright Company, Toledo, Ohio. 5½x8¾ ins., 8 pages. Relates to causes and prevention of failure in creosoted wood block factory floors. Reprint of paper by Mr. Ericson at 1918 convention of American Wood Preservers' Association.

TARVIA K. P.—Issued by the Barrett Company, New York City. 3½x6 ins., 16 pages. Illustrates and describes each step in patching a road with Tarvia K. P. (kold patch).

Personal Items

Ray S. Blinn is now first assistant engineer of the United States Army Ordnance Department at the Camp Perry Proving Grounds, Fort Clinton, O. He was formerly division engineer on the Illinois Central Railroad, engineer in charge of paving at Columbus, O., city engineer and director of public service at Mt. Vernon, O., city manager of Westerville, O., and consulting engineer for Arthur A. Graham, paving contractor, of Mount Vernon, O.

Virgil G. Marani has been appointed chief engineer of the Gypsum Industries Association, with headquarters in the Harris Trust Building, Chicago. For several years past he has specialized on gypsum products in their application to structural uses. The information he has gathered on this subject will be made available to architects and builders, who are invited to consult, without cost, the Gypsum Industries Association. Mr. Marani graduated from the civil engineering department of Toronto University in 1893. His first engagement was with Mann & White, on canal work for the city of Buffalo. He was next sanitary engineer for Cleveland, O. For 10 years following 1896 he was construction engineer for the Cleveland Gas, Light and Coke Company. He then opened private offices in Cleveland and had supervision of the construction of the Cuyahoga County Courthouse Building, a $5,000,000 job. In 1910 and 1911 he was building commissioner of Cleveland, and revised its building code. In 1912 he had charge of the erection of floors and fire-proofing for various large buildings in Cleveland. For the last five years he has been consulting engineer for the United States Gypsum Company, being also in charge of their information and promotion departments.

George A. Johnson, consulting hydraulic and sanitary engineer, New York City, has accepted a commission as major in the office of the Construction Division, War Department, Washington, D. C.

W. G. Goodwin has been appointed chief engineer and superintendent of the Kansas City, Mo., water department, to succeed Burton Lowther.

Roy G. Buck has resigned his position as assistant engineer with the Indianapolis Water Company, and has taken a position with C. H. Hurd, consulting engineer, Merchants Bank Building, Indianapolis, Ind.

John M. Goodell has been appointed consulting engineer of the United States Office of Public Roads and Rural Engineering. He will represent the Office of Public Roads and Rural Engineering on the United States Highway Council.

Chas. E. Ashburner, who has been city manager of Springfield, O., since January 1, 1914, will become city manager of Norfolk, Va., on September 1. He is well known as the first of the city managers. He was city manager at Staunton, Va., from April, 1908, to July, 1911. From then until he went to Springfield, O., as city manager, he was in railway work.

Lieut. John W. Kelsey has been appointed superintendent of the Bureau of Water at St. Paul, Minn. The appointment is the result of a competitive civil service examination. Lieut. Kelsey is now on duty at Camp McClellan, Ala., and the position of superintendent of the St. Paul Bureau of Water will be held open for him until his return. He succeeds G. O. House, who resigned the office to become superintendent of the St. Paul City Railway Lines.

Wilbur A. Ginn, Sanford, Fla., was employed by the Board of Public Works of Sarasota, Fla., preliminary to taking over the Franchise Company's lighting plant. Mr. Ginn's studies contemplated the consolidation of the plants under new powers with improvements and extensions. The new work will comprise an up-to-date power plant, utilizing the most economical war fuel. Water and sewer mains will be extended to insure a general distribution of the city water to accommodate the fast growing suburban districts.

If German Airplanes were in the sky

If German Airplanes were in our sky their first concern would be to bomb our railroads and highways, for they know that to tie up traffic is to paralyze the country's activities.

Yet our own carelessness is helping to accomplish for Germany what her air-fleet cannot accomplish at present!

For every road that is muddy and full of ruts and bumps and holes is impeding traffic, wearing out horse-flesh, ruining motor vehicles, and effectively slowing up our progress.

America Needs Good Roads to Win the War

Good Roads are necessary to mobilize the crops, to make the farms efficient, to make the back-country produce;

To mobilize the coal and ores, to open mines that have no rail connections;

To mobilize the manufacturers, to keep them connected and supplied, to bring away their mountainous out-puts when the railroads are choked;

To mobilize labor, to bring the workers from distant homes to new plants;

To quicken the pulse and speed the communications of a nation that is still only half awake to the war.

England and France have not postponed or neglected road maintenance. Efficient roads mean more to them than ever. A short cut, a flatter grade, a contour that permits speed, a surface that permits heavy loads, counts for more today than they ever did!

"Good Roads" today Means "Tarvia Roads"

Tarvia roads are economical of maintenance and economical of labor. They are mudless, dustless, and durable. Their cost is lower than any other type of highway *capable of carrying motor-truck traffic.*

The most effective, and in fact the only way, to relieve the present railroad congestion is to use the motor-truck more and more for the short hauls.

Hundreds of thousands of tons of food, fuel and munitions can be quickly and economically moved in this way.

But this cannot be accomplished unless the roads are kept up. Therefore it is the duty of every official and every citizen to see that the arteries of our national life are not neglected.

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This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by any one interested.

If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

Booklet free on request.

Lower photo, taken in September, 1916, shows the road to Guillemont, France, rapidly being effaced under bombardment (Central News). Above is a German airplane dropping a bomb (© Underwood & Underwood).

CONTRACT NEWS

CONTRACTS AWARDED

ROADS AND STREETS.

Ala., Florence—Newell Bros., Birmingham, Ala., award. contr. to extend Huntsville, Rd.—Killen through Center Star—at abt. $30,000.

Ark., Lewisville — Taylor Constr. Co., Texarkana, award. contr. for bldg. hwy. across Lafayette Co., at $126,000.

Cal., Long Beach — Fairchild-Gilmore-Wilton Co., Pacific Electric Bldg., Los Angeles, award. contr. for paving Cherry Ave. —Broadway to center line of 11th St., at $39,281.

Cal., Los Angeles — Fairchild-Gilmore-Wilton Co., Pacific Electric Bldg., Los Angeles, award. contr. for constr. of asph.-macad. pavement on conc. base on Cherry Ave., at $39,281.

Cal., Los Angeles—M. S. Cummings, 1302 W. 22nd St., award. contr. by Bd. Pub. Wks,, to improve Carillo St.—W. Kensington Rd., to Bellevue Rd.—at $16,082.

Cal., San Diego—John Engebretson, local, award. contr. for perm. conc. road on North Island, to connect units of perm. bldgs. for naval air sta., at $33,696.

Cal., Santa Ana—Wells & Bressler, R. 3, California Bank Bldg., Santa Ana, award. contr. for paving Bristol St., at abt. $15,200.

Cal., Santa Barbara—Fairchild-Gilmore-Wilton Co., Los Angeles, award. contr. for improving Canal St., Micheltorena to Valerio Sts.—also Arrelaga St., Canal St. to Pueblo line—at $12,731.

Cal., Stockton—Frank G. McIntire, Stockton, award. contr. for completing Calaveras State Hwy. lateral, San Joaquin Co., at $46,494.

Ohio, Columbus—Joseph Karsch, Selina, award. contr. by State Hwy. Comn., for grading and paving with brick on rolled base, Sect. H., Lima-Ottawa Rd. (94 miles) —at $32,486.

Conn., New Haven—Franklin Contg. Co., 52 Vandelbilt St., New York City, award. contr. for paving Mechanic St.,—Edwards to Willow Sts; also re-surfacing Edwards St., at $16,996 and $18,916, respectively; C. W. Blakeslee & Sons, Waverly St., award. contr. for paving with concr. cem., Quinnipac Ave.,—Clifton St. to Foxon Rd.—at $28,827.

Ct., New Haven—L. W. Blakeslee & Sons award. contr. for paving Hillside Pl., at abt. $10,851.

Ill., Chicago—Andrew Ward & Sons, Oak Glen, Ill., award. contr. for paving ¾ mile Cumberland Ave., 6 to 8-in. conc., 18 ft. wide, with 6 earth shoulders—at $21,046.

Ill., Joliet—R. F. Conway Co., award. contr. for paving McDonough St.—Chicago St. to the bridge—at $22,352.

Ill., Waukegan—Pat Moran, Waukegan, award. contr. for paving Market St., at $37,237.

Ill., Waukegan—Eclipse Construction Co., award. contr. for North Sheridan Rd. improvement (sections 1 and 2) at $62,811 and $40,045, respectively; contr. for supplying the cem. award. to J. E. Hussey, Lake Forest—at $35,700.

Ind., Delphi— Cowden & Co., award. contr. for two gravel rds. in Jackson and Jefferson Twps., Caroll Co., at $11,770.

Kans., Topeka—Union Paving & Constr. Co., St. Joseph, Mo., award. contr. for paving W. 10th Ave. rd.—city limits to 1 mi. west of Gage Park entrance, at $44,564.

Ky., Newport—Metzel & O'Hearn, 22 W. 19th St., Covington, Ky., award. contr. for paving Monmouth St., at $39,200.

Md., Baltimore — Arundel Construction Co., 329 S. Caroline St., City, award. contr. for cement conc. paving in private alleys, at $33,501.

Mass., Boston—James Doherty, award. contr. for paving portion of Dorchester Ave., at $26,570; Coleman Bros. contr. for paving with granite block, Clinton St.—Merchants Row to Commercial—Cross St. Commercial to Haymarket Sq.—and Mercantile St.,—So. Market to Richmond—at $52,382; Jas. Doherty, contr. for paving with smooth granite blk. on conc. base, Dartmouth St.,—Tremont to Stuart Sts., S. End, at $38,375; Warren Bros. Co., contr. for paving with Filbertine Park St.,—Tremont to Beacon, also Somerset—Beacon to Ashburton Pl., and Tremont St.,—Boylston to Common St., at $14,674.

Mass., Holyoke—D. O'Connell & Sons, 480 Hampden St., award. contr. for paving Dwight St.,—Elm St. to Whitney Ave.,—at abt. $12,400.

Mich., Detroit—Detroit Asph. Paving Co., City, award. contr. for grading and paving with asph.-conc. Miller rd., at $62,082; McGraw Ave., at $1,974; Forest Ave., at $10,-526; Greusel Ave., at $7,814; Griggin Ave., at $5,654; Runn Rd., at $44,807; W. B. Brady Constr. Co., City, award. contr. for Clarendon Ave., at $15,658, Fernwood Ave., at $13,262; Arcadia Ave., at $6,960; Thos. E. Currie, contr. for grading and paving with 2-in. top. conc., Rippelle St., at $3,331.

Mich., Muskegon—Markle Cement & Coal Co., award. contr. by City Council for creo. blk. paving on Ottawa and Lake Sts., at $100,945.

Minn., Pipestone—C. C. Walkup & Son, general contract for graveling 21 mi. of road in Lyon Co., at $50,000.

Mo., Columbia—Sherwood & Myers, 820 Landers Bldg., Springfield, award. contr. for bldg. 37 miles Jefferson Hwy., conc., at about $164,479.

Miss., Canton—Maxwell & Doty, Camden, award. contr. by Madison Co., for grading and surfacing 18 miles of road, 20 ft. wide, sand and clay, at abt. $60,000.

Mo., Independence — Davidson Bros., Kans. City, award. contr. for grading and macadamizing portion Sterling Douglas Rd.—Columbus to Rock Creek—at $14,615.

Mo., Independence—J. Welsh, Kans. City, award. contr. by Jackson Co., to grade and macadamize Lone Jack East Rd., at $45,675; J. A. Shedy, Kans. City, award. contr. to grade Levasy-Mecklin Rd., at $20,000.

Mo., Independence—Kansas Constr. Co., Armour Blvd., & Locust St., Kans. City, Mo., award. contr. to grade and macadamize 3½ miles of Frank Frick Rd., at $15,639.

Mo., St. Louis—Skrainka Constr. Co., Security Bldg., St. Louis, award. contr. to pave Dresden Ave.,—Gravois to Eichelberger Sts., at $12,996.

Neb., Fullerton—Natl. Rfg. Co., Omaha, award. contr. for paving in Dist. No. 6, at $45,400.

N. J., Belvidere—Salmon Bros., Netcong. award. contr. for Hope-Bridgeville Rd., at $46,966.

N. J., Freehold—Fireproof Realty & Constr. Co., 55 Magnolia Ave., Jersey City, award. contr. for 2 mi. of road between this city and Marlboro at $64,839.

N. J., Garfield—Jno. T. Harrop Co., award. contr. to improve Passaic St., at $27,464.

N. J., Jersey City—W. T. S. Critchfield, Greene St., award. contr. for paving Princeton Ave.—Gates Ave. to Brown Pl.—(asph. on conc. base) at 117% of engineer's estimate of $24,000.

N. J., Ridgefield—Job & Sons, award. contr. for perm. improvement of Grant Ave. —at $37,350.

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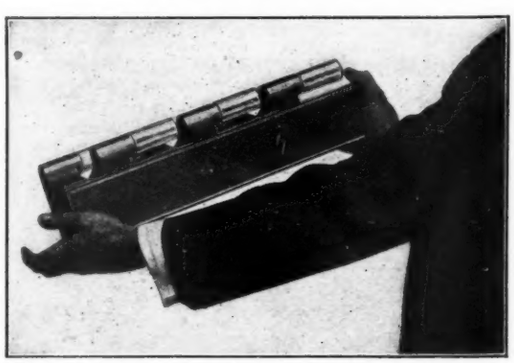

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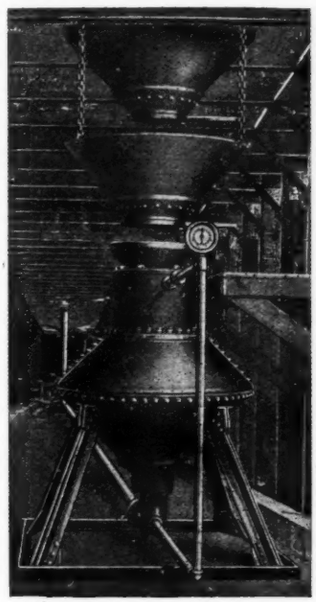

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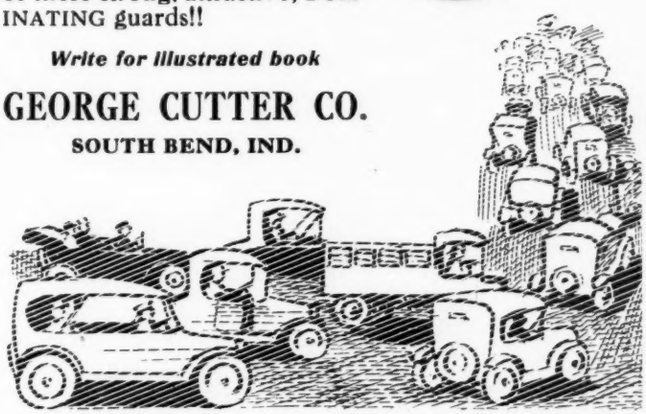

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N. J., Ridgefield Park—Maurice J. O'Connell, award. contr. for improvement of Main St.,—Winant Ave. to Preston St.—at $38,311.

N. M., Las Vegas—J. Collier, Denver, Colo., award. contr. for paving number of streets, at about. $19,855.

N. Y., New York—F. L. Dowling, Boro. Pres. award. following contracts for repaving with sheet asph. on conc. foundation, rdways of: 28th St., 8th to 10th; 51st St., 8th to 9th Aves.; also 10th to 11th Aves; 20th St., 7th to 8th Aves.; 48th St., 8th to 11th Aves.—to Cleveland Trinidad Paving Co., Main St., Flushing, L. I., at $26,268, $29,241, $15,032 and $4,520, respectively; 5th St., Ave. D. to C, to Uvalde Asph. Paving Co.; 1 Bway at $12,789; 115th St., Pleasant to 2nd Aves—to Davney Asph. Co., 1170 Bway., at $23,400.

N. D., Carrington—Stanley Bros., St. Paul, Minn., award. contr. for grading 16 miles of road in Foster Co., at $18,000.

N. D., Fessenden—Druhe & Kemper, Minot, award. contr. by Wells Co., for construction of road work, at $19,666.

N. D., Jamestown—Stanley Bros., St. Cloud, award. contr. for road work, at $15,-800.

O., Bellefontaine—McHugh Bros. Springfield, award. contr. for constr. of one sect. of Bellefontaine-Huntsville conc. road to extend 2.84 mi. from infirmary rd. to Huntsville, at $78,722.

O., Cincinnati—Sullivan & Henkel, award. contr. for repairing the Carthage-Hamilton rd., at $54,963.

O., Cincinnati — Henry Westerman, Barnesburg, O., award. contr. for improve-of Gaines Rd., Sheed Rd. to Taylor Crk., also Springdale Rd. in Coleral Twp., at $11,872.

O., Cleveland—Bentley Bros. Co., Electric Bldg., award. contr. for grading, draining, curbing, paving, etc., on Prospect Ave., at $59,266.

O., Fremont—Modern Constr. Co., City, award. contr. for bldg. 4-mile stretch of rd. on Maumee Pike, just east of Clyde, at about $184,038.

O., Lima—Andrews Asph. Co., award. contr. for repair of all Lima asph. streets in need of improvement, at $2.25 per sq. yd.; Blodgett & Mullen, award. contr. for paving Metcalf St., Hazel Ave. to Murphy St., with brk., at $16,865.

Okla., Ardmore—Tom Ottinger, award. contr. for bldg. rd., at $20,000.

Okla., Durant—R. Y. Walker, Okla. City, award. contr. to construct Fed. Proj. No. 5, at $125,000.

Okla., Lawton — Western Paving Co., Okla. City, award. contr. to construct Fed. Proj. No. 4—Fort Sill Blvd., from Lawton City limits to so. line of Ft. Sill military reservation—at $43,000.

Okla., Okla. City—M. A. Swatek and Western Paving Co., both of Okla. City, award. contr. to construct Fed. Proj. No. 3—2 mi. hard rd. on 23d St.—at $47,000.

Okla., Okla. City—M. A. Swatek, Okla. City, award. contr. for constr. of 1 mile of rd. on Eastern Ave., no. from 23d St., ½ mi. on Lincoln Blvd., no. from Capitol, and ½-mi. on Normal Rd. so. from city, at $26,-000.

Okla., Ponca City—Park-Moran Co., P. O. Box 622, Okmulgee, Okla. award. contr. to construct 65 blocks of 2½-in. vert. fibre brick paving, at abt. $200,000.

Ore., Astoria—Warren Constr. Co., award. contr. for clearing and grading 2½-mi. of rd. to complete hwy. to Young's River Falls, at $25,025.

Ore., Astoria—C. G. Palmberg, City, aawrd. contr. for 7th St. improvement, at $72,490; also for improving 14th and 15th Sts., with vitr. brick pavements.

Ore., Bay City—Adolph Erickson, award. contr. for improving one mile of road at approx. $12,500.

Ore., Portland—Warren Constr. Co., Journal Bldg., award. contr. for paving 18 ft. strip on Foster Rd.—82nd to 102nd Sts.; also paving 82nd St., Clarkamas Co. line to Division Sts., and down Division St. to present pavement on 62nd St., at abt. $79,-138.

Ore., Portland— Warren Constr. Co., Journal Bldg., award. contr. for bldg. Derby St. approach to Interstate bridge, wearing surface on crushed rock base, at $27,-152.

Ore., Portland—Warren Constr. Co., City, award. contr. for paving approx. 6 miles county hwy. at abt. $112,513.

Pa., Erie—Mayer Bros. Construction Co., Commerce Bldg., award. contr. for paving 1,200 ft. Parade St., 68 ft. wide, involving 7,700 sq. yds. asph., and 970 sq. yds. brk. block, at $24,872.

Pa., Harrisburg—O'Brien Bros., Parsons, award. contr. by State Hwy. Dept. for constr. of 1.96 mi. of block rdway. in Plains and Jenkins Twps., Luzerne Co., at $109,-560; T. H. Gill & Co., Whitney Point, N. Y., award. contr. for 15,774 ft. on route No. 72, Butler Co., at $127,586 and 5,900 ft. in E. Bethlehem Twp., Washington Co.; Pitt Constr. Co. Co., Pittsburgh, contr. for state aid work, at $64,973.

Pa., Harrisburg—J. Ross Mayer, Erie, award. contr. by State Hwy. Dept., for bldg., 15,918 ft. of 3.01 miles State Hwy. Route 84, at $109,134.

Pa., Harrisburg—Jno. T. Blair, Ebensburg, award. contr. for bldg. brk. road, 11,-336 ft. long, on State Hwy. Route No. 62, at $118,602; B. H. Coryell, Williamsport, award. contr. for constr. of 2,430 ft. rein. conc. paving 16 ft. wide in Avis Boro., Clinton Co., at $16,465; Horn & Devling, Galeton, award. contr. for bldg. 11,800 ft. rein. conc. rdway. on State Hwy. Route 101, Roulette Twp., Potter Co., at $87,103; Geo. Serafini, Binghamton, N. Y., award contr. for construct'g 7,824 ft. rein. conc. rdway. on State Hwy. Route 103, Tioga Co., at $56,194.

Pa., Philadelphia—John Meehan & Son, award. contr. for construction of circular driveway around Logan Square at $146,791.

Pa., Plymouth—E. Quinn, W. Main St., award. contr. for grading, repaving and resetting curb on W. Main St., at $10,000.

Pa., Sewickly—McPherson Bros., 431 Chestnut St., award. contr. for improving Broad St., at about $14,567.

Pa., So. Brownsville—Petrill Bros., award. contr. for grading, curbing & vitr. brick paving on 5 strets, at $81,356.

R. I., Providence—B. Perini, Ashland, Mass., award. contr. for paving 7,230 ft. of rd. betw. Warren and Bristol—bitum. conc. surface on crushed stone base—at $40,545.

S. C., Spartanburg—Southern Paving & Constr. Co., Chattanooga, Tenn., award. contr. to construct roads to Camp Wadsworth, at $126,000.

Tex., Dallas—Texas Bithulithic Co., 1106 Praetorian Bldg., Dallas, award. contr. to pave Lemmon Ave., Cole to Howell; also Coke to Cole Aves.; and Travis St.,—Lemmon Ave. to Bows—at $30,737 and $3,106, respect.

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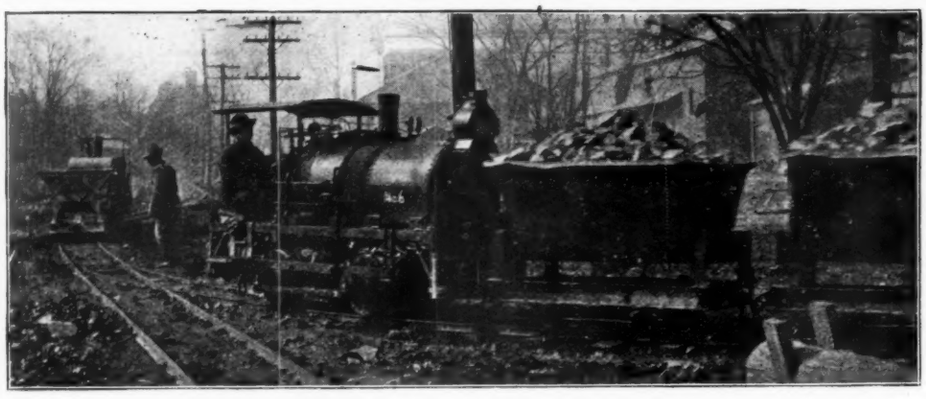

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30 Church Street. (Founded 1908) New York City.

Tex., Georgetown—Williams Co. Commrs. award. contr. to Hermon Brown, Temple, Texas, to complete Meridian Hwy, at $82,-000.

Va., Roanoke—Albert Lee Marshall, City, award. contr. for repairing approaches at the U. S. Postoffice, at $2,442.

Va., Tazewell—G. T. Franklin & Co., Pocahontas, Va., award. contr. to construct 5 mi. water-bound macad. hwy., at $35,000.

Wn., Bremerton—R. H. Travers, 3144 Arcade Bldg., Seattle, award. contr. to improve 5th Ave., and Pacific St., at $65,000. Work will include 11,000 sq. yds. paving, as well as laying sewers and watermains.

Wn., Chehalis—John Ward, City, award. contr. for constructing 1⅛ mi. of change of National Pk. Hwy., around foot of Claquato Hill, at $5,757.

Wn., Colfax—Mitchell Bros., award. contr. for grading, draining and surfacing with crushed rock Spring Flat Four Mile Rd., $88,406.

Wn., Ephrata—Northwest Paving Co., award. contr. for constr. of perm. hwy. No. 10, 3 miles, at $14,404; C. G. Betts, award. contr. for constr. of perm. hwy. 12, at $5,-534.

Wn., Everett—Kaiser Constr. Co., City, award. contr. by Snohomish Co. Commrs., for paving Ebey Island trestle near here, perm. hwy. No. 32-A, at $13,843.

Wn., Prosser—Warren Constr. Co., Journal Bldg., Portland, Ore., award. contr. for grading, paving and curbing strets in Local Impvt. Dist. 27, involving 39,100 sq. yds. bitum., 12,500 cu. yds. grading and 3,520 lin. ft. of curb, at approx. $99,577.

Wn., Seattle—J. A. Fletcher Co., Luzerne Apts., award. contr. by King Co. Commrs., to pave 2.31 miles perm. hwy. No. 18, beginning at so. limits of Kent and running thence north toward Orilla, at $58,455.

Wn., Seattle—V. Bressi, 853 Rainier Ave., award. contr. for paving Howard Ave., at $29,078.

Wn., Vancouver—O. D. Wolf, Washougal, Wn., award. contr. for improving hwy. bet. Vancouver and Camas, at $32,780; also for constr. perm. hwy. No. 3-B with water-bound macad., at $26,000.

W. Va., Huntington—Harrison & Dean, 322½ 9th St. award contr. for bldg. and paving 1½ miles Midland Trail betw. Ona and Milton at following unit prices: excav., 60c cu. yd.; curbing, 18c lin. ft.; paving, 85c sq. yd. Material will be furnished by county for 620,000 Dixie wire cut blk. to Peerless Paving Brk. Co., at $24 per 1,000.

W. Va., Moundsville—H. Coss, Wheeling, award. contr. by Marshall Co., for repaving and regrading 1.3 mi. Narrow Rd., at abt. $50,000 (percentage basis).

Wis., Burlington—E. H. Merrick, Kenosha, Wis., award. contr. for grading, approx. 5,100 sq. yds., at $1,39 per sq. yd.

Wis., Madison—N. Quinn, 515 Johnson St., Madison, award. contr. by State Hwy. Comm., for bldg. Madison-Middleton Rd., Dane Co., at abt. $79,754.

Wis., Merrill—Geo. Langley, Sr., local, award. contr. for grading Fed. Trunk hwy., at abt. $10,000.

Wis., Superior—Russell Constr. Co., award. contr. for paving Cadotte Ave., from W. 5th St. to Bardon Ave., at $9,407.

Wis., Weston—J. Hilbert, Wausau, Wis., award. contr. for bldg. conc. rd., in Dunn Co., at $10,500.

SEWERAGE AND SEWAGE TREATMENT.

Ala., Sheffield—Sullivan, Long & Haggerty, Bessemer, Ala., award. contr. to construct 6½ miles of sewers, at $75,000.

Ark., Ft. Smith—Phoenix Cement & Sidewalk Co., City, award. contr. for construct. ing 7,500 ft. 8-in. sewer, 17 manholes and 5 lampholes, at abt. $8,365.

Cal., Petaluma—Bailey-Comstock Co., will be awarded contr. for sewer improvements at $6,622, as soon as bonds are sold.

Cal., Richmond—T. B. Clinch, Richmond, award. contr. for constr. of sewers in the Brown Andrade and Overland tracts, at $3,996.

Cal., Stockton—Jno. Heafey, Bacon Bldg., Oakland, award. contr. for construction of Reinsch-Wurl screen sewage disp. plants for both the north and south sections of the city, at $156,000.

Ct., Waterbury—R. D'Iro & Co., 88 E. Main St., award. contr. for bldg. sewers in Beacher, Inglewood and Wildemere Aves.; also Knoll St., at abt. $19,380.

Ill., Chicago—Nash Bros., award. contr. for constr. of Desplaines River sewer, at $568,000. Proposed sewer will start at no. end Maywood and run south on 1st and 2d Aves. to Speedway park on W. 12th St., at which point a pumping sta. will be erected for treating the sewage and pumping same into Desplaines River.

Ill., Chicago—T. J. Forschner Contg. Co., West Pullman, award. contr. by Trustees San. Distr., for bldg. sewage pumping station at $724,000.

Ind., Elkhart—Frank J. Miller, award. contr. by Elkhart Bd. of Works, for installing sewer on Wagner Ave.—6th to 9th Sts. —at $2,948.

Ind., Evansville—Walker Hedges, Owensville, Ind., award. contr. for conc. work in constr. of 5 new laterals, at $2,658.

Ia., Cedar Rapids—J. B. Ford & Son, award. contr. for installing sanitary sewer in Daniels Park addn., at $2,751.

Ky., Paducah—J. B. Gardner, City, award. contr. for constructing storm sewer from 8th and Jones Sts. to river, at $9,078.

Ky., Paris—D. A. Sant, Cincinnati, award. contr. for bldg. sewer sys., embracing 2 miles of surf. and san. sewers, at $19,800.

Mass., Athol—W. G. Ferrullo & Co., 31 North Square, Boston, award. contr. for about ¼-mile 8-in. vit. pipe line, at $4,000.

Minn., St. Paul—E. T. Webster, 437 Beacon St., City, award. contr. for constr. storm water relief sewer on Como Ave., at $5,387.

Minn., Duluth—John Hedberg, City, award. contr. for constructing sewer in 8th alley—46th to 47th Ave., W., in 47th Ave., etc., at $2,423.

Minn., St. Paul—J. W. Hildred, City, award. contr. for furnishing and installing 2 elec. driven pump'g. units in duplicate for pump sta. West St. St. Anthony Pk. san. sewer system, at $2,142.

Mont. Scobey—Geo. W. Kemper, Minot, N. D., award. contr. for constr. of sewerage and disposal plant, at $9,965.

Mont., Wolf Point—C. H. Kelley, Kalispell, award. contr. for constr. of city sewage sys., at $18,583.

Beatrice, Neb.—Intermountain Brdg. & Constr. Co., Tecumseh, for constr. sewers, at abt. $18,238.

N. J., Paulsboro—C. F. Hamilton, Inc., Franklinville, N. J., award. contr. for bldg. sewage disposal sys., at $100,000.

N. Y., Flushing—Jos. L. Sigretto & Co., low bidder for constr. of trunk sewer in

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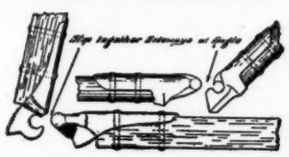
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51st St. (Central Ave.) Lurting (Willow) St., to Waldron St., (Lawn Ave.), Corona, at $346,403.

N. Y., Niagara Falls—Dominick Penders, award. contr. for laying sewer in an open ditch in Union St., at $6,280.

N. Y., Niagara Falls—Wm. Reach, award. contr. for constr. of sewers in Linwood Ave. and Sugar St., at $328 and $5,000, respectively.

O., Cincinnati—M. J. Connelly Constr. Co., award. contr. for constr. of sewer on Carthage-Hamilton Rd., at $36,136.

O., Cleveland—N. Iaformaro, Cleveland, award. constr. for bldg., sewer in East 138th St.,—Woodland Rd. to St. Clair St. —$16,000.

O., Cleveland — Donnelly & McKeon, award. contr.. by Bd. of Control, for constr. of sewer in Governor Ave., SW—Bosworth Rd. SW to W. 105th St., at approx. $6,100.

O., Columbus.—B. B. Sheets Co., Pittsburgh, Pa., award. contr. for completing 3d Ave., relief sewer, 4th Ave. Sect., at $43,310.

O., Euclid—D. Psahl, Guardian Bldg., Cleveland, award. contr. for constructing sewers in various strets at $100,000.

O., Kenmore—McShaffrey & Son, 173 S. Forge St., Akron, award. contr. for constructing sewer to run through Kenmore Blvd., at $72,213.

O., Sandusky—Homberger & Wagar, award. contr. to build sewer from the 1st alley east of Camp St. to Central Ave., at $3,207.

Okla., Tulsa—Comstock & Hansen, Cedar Rapids, award. contr. for bldg. sewerage system, at $45,153.

Pa., Philadelphia—Edw. F. Bemis, Philadelphia, award. contr. by Rear-Ad. Francis T. Bowles, Emergency Fleet Corp., for laying sewers in one of the 40th ward housing tracts.

Tex., College Station—H. W. Cardwell Constr. Co., Texarkana, award, contract to constr. sewer line and sewage disposal plant for A. & M. College, at $15,000.

Tex., Waco—Isaacs-Worsham Constr. Co., Waco, award. contr. to construct Cameron Park extension of sewer system to connect with Camp MacArthur, at $4,211.

Va., Richmond—H. L. Driscoll, Richmond, award. contr. for bldg. Hull St. sewer, at $5,757.

Va., Richmond—H. L. Driscoll, local award. contr. to construct sewer in Meadowbridge Rd.—Valley Rd. to Cannon St.—at $3,965.

Va., Roanoke—Tinsley Constr. Co. award. contr. for storm drain in Kirk Ave., betw. Jefferson and Nelson Sts., at $30,000.

Wn., Bremerton—R. H. Travers, 3144 Arcade Bldg., Seattle, award. contr. to improve 5th Ave. and Pacific St., in distr. which Govt. has commandeered for housing project. Work consists of laying sewer and water mains; also paving. Total of contract, $65,000.

W. Va., St. Albans—Mapes & Hurley, Marion, award. contr. to construct san. sewer at $25,000, involving 15,000 ft. 8 to 15-in. terra cotta pipe; also 16,000 cu. yds. earth trenching.

Wis., Berlin—Mastin & Lennon, Berlin, award. contr. for constructing sewers, at $5,484.

Wis., La Crosse— Thill-Manning-Whalen Co., La Crosse, award. contr. for construction sanitary sewer at $2,335.

Wis., Oshkosh—Chris. Johnson, award. contr. for construction of sewers at $2,921.

Racine, Wis.—E. R. Harding Co., award. contr. for bldg. complete sewer system in Grove Ave. and adjacent territory, at $94,658.

Wis., Washburn—Gray, Robinson & Co., Manitowoc, award. contr. for nine blocks sewer work, at about $10,000.

WATER SUPPLY AND PURIFICATION.

Ala., Montgomery — Layne & Bowler, Memphis, Tenn., award. contr. to provide addn. daily water supply of 2,000,000 gals.; constr. to include 200,000-gal. standpipe, drilling wells, etc., $100,000.

Cal., Monrovia—Western Pipe & Steel Co., Los Angeles, award. contr. for furnishing approx. 12,000 ft. 16-in., 4,500 ft. 15-in., and 1,500 ft. 8-in. riveted steel pipe for new water main, at $20,000.

Colo., Brighton—J. S. Schwartz, Colo. Springs, award. contr. for bldg. new pumping sta., with 1,200 gals. per min. capy., water tank and elec. steel tower and laying new pipes, involving 15,000 ft. 4, 6, 8 and 10 in. c. i. pipe., at about $16,000.

D. C., Washington—DeLaval Steam Turbine Co., New York City, award. contr. for furnishing steam driven centrif. pump outfit for water dept., to have daily capy. of 15,000,000 gals. to be installed in Bryant St. Sta., in connection with the filtration plant, at $37,950.

Ill., Hillsboro—Field & Shorb, Decatur, award. contr. for furnishing pipe to be laid from the wells to city limits—abt. 3,000 ft. at abt. $5,000; same company also received contr. for well casings and well screens for 2 wells at abt. $700.

Ill., St. Charles—F. M. Gray, Jr., Milwaukee, Wis., award. contr. for drilling well 2,200 ft. more or less, on premises near present city plant, at $6,440.

Kan., Baxter Springs—Amer. Pipe Co., Kansas City, award. contr. for bldg water mains and hydrants, at abt. $85,000.

Mich., Ann Arbor—Holland, Ackerman & Holland, 122 Fourth Ave., award. contr. for bldg. water supply system, at abt. $200,000.

Mich., Ironwood—Peter Kegan, City, award. contr. for excavating and constr. conc. reservoir of 1,000,000 gal. capy., at $20,245.

Minn., Franklin — Franklin, Minn.— McCarthy Well Co., St. Paul, award. contr. for digging clear water well 12 inches in diam., at $30,465.

Minn., Ogilvie—Wm. C. Fraser, St. Paul, award. contr. for pipe line at $6,366 in waterworks system; Circular Concrete Co., 100 Corn Ex., Minneapolis, award. contr. for conc. tower and tank at $6,575.

Mont., Scobey—Geo. W. Kemper, Minot, N. D., award. contr. for installing water sys., at $24,646.

Neb., Mitchell—Pacific Tank & Pipe Co., San Francisco, award. contr. for 835 ft. 54-in. continuous stave pipe for Lingle power plant, at $5,577.

N. J., Trenton—W. J. Warren, Princeton, award. contr. for repairs to the water supply system at State Village for Epileptics, at $13,945.

N. Y., Brooklyn—Knight & De Micco, 2353 Washington Ave., New York City, award. contr. by Comr. Water Supply, Gas & Elect., for hauling and laying water mains in Bay East 28th and 61st Sts., 8th and Newport Aves., at $39,063.

N. Y., Corona—L. J. Sigreto & Co., Brooklyn, award. contr. for bldg. trunk sewer in 51st St.—Lurting to Waldron Sts. —at $346,493.

N. Y., Watervliet—American Water Softener Co., Philadelphia, award. contr. for installing additional filters at filtr. plant of new water works sys. in Colonie, at $26,500.

N. C., Raleigh—Tucker & Laxton, Charlotte, award. contr. for installation of additional machinery in water works plant; also intake pipe; A. Kykoff & Sons Co., Elmyra, N. Y., contr. for 3,300 ft. 24-in. wood stave and specials. Total cost of contracts, $40,000.

N. D., Hillsboro—J. M. Carroll, Grand Forks, award. contr. for 6-in. water main exten. on Sargeant St.,—intersection with Caledonia Ave., at $2,823.

O., Alliance—Pitt Constr. Co., Fulton Bldg., Pittsburgh, Pa., award. contr. for constructing addns. to filtration plant, comprising conc. circular reservoir 127 ft. in diam.; rein. conc. coag. basin; small pump house, c. i. pipe lines and all appurts., at abt. $98,000.

O., Bluffton—Skelton Engrg. Co., Toledo, award. contr. for remodeling water and light plant, at abt. $35,000.

O., Springfield—M. J. Cooney, Springfield, award. contr. for laying 2,700 ft. 6-in. water works extension in Snyder St., through Snyder park to plant of Victor Rubber Co., at abt. $6,049.

Okla., Waurika—National Water Purifying Co., Kaufman, Tex., award. contr. for constructing new water system, at $19,750. Work consists of bldg. dam across Beaver crk., 2 big basins with capy. 200,000 gals. each; brk. and conc. pump house, 24x30; 2 crude oil engines 25 h. p. each and 3 new pumps, two of which have capy. 200 gals. per min. and one 1,800 gals per. min.

Ore., Eugene—United Iron Works, Oakland, Cal., award. contr. for installing pump at well, at $5,000.

Pa., Yorktown—F. W. Constr. Co., 1701 Finance Bldg., Philadelphia, award. contr. for bldg. conc. reservoir and pump well, at abt. $700,000.

Tex., Fort Bliss—Jennings Constr. & Engr. Co., El Paso, award. contr. for water pumping plant, at $25,000.

Tex., Abilene—R. C. Lewis, Abilene, award. contr. to construct earthwk. and conc. work for Elm Crk. dam for water supply, at $181,991. Impound 5,500,000,000 gals. water.

Utah, Brigham City—Parrett & Thompson, Salt Lake City, award. contr. for constructing water works sys., at $22,600.

Wis., Fond du Lac—Ahern-McCoy Co., award. contr. for constr. of water & sewer systems; also equipment, at fair grounds. Complete sys. of water mains, fire protection, sewers, etc., planned.

Wis., Shawono—Mich. Pipe Co., Chicago, award. contr. for 400 ft. 6-in. wood stave pipe; 100 ft. 60 in. galv. iron pipe and fittings, award. to Rundle-Spence Mfg. Co., 16 2d St., Milwaukee, $2,500.

Wyo., Newcastle—Security Bridge Co., Billings, Mont., award. contr. for constructing water works system, at $75,000.

BRIDGES AND BUILDINGS.

Cal., Sacramento—W. M. Ledbetter & Co., Pacific Electric Bldg., Los Angeles, award. contr. for constr. of rein. conc. arch brdg., across Arroyo Honda, Santa Barbara Co., at $49,750; DeWaard Bros., 207 Granger Blk., San Diego, award. contr. for con-

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structing one 60-ft. brdg. across Slate Crk. and one 30-ft. across Doney Crk., Shasta Co., at $11,904.

Cal., Salinas—Daniel R. Wagner & Co., award. contr. for constr. of brdg. across Thompson's gulch near King City, at $10,690.

Cal., Santa Ana—Chris McNeil, award. contr. for steel bridge at Main St. conc. piers and abutments, at $46,812; Wells & Bressler, bridge at Flower St., at $11,175.

Colo., Denver—Colorado Bridge & Constr. Co., City, award. contr. for constructing bridge over Clear Crk. on Clear Crk. Ave., at $11,990.

Del., Wilmington—John P. Reardon, award. contr. for replanking bridge at Washington St., at $13,873.

Fla., Pensacola—Converse Bridge & Steel Co., Chattanooga, Tenn., award. contr. by Escambia Co. Commrs., to construct rolling lift bridge over Bayou Chico, at $43,413.

Ga., Valdosta—J. B. McCrary Co., Atlanta, award. contr. to construct conc. bridge on national hwy. across Withlacoochee River. est. cost $40,000 to $50,000, of which government will pay $25,000.

Ida., Twin Falls—Midland Bridge Co., 504 Ry. Exchange Bldg., Kans. City, Mo., award. contr. for constr. of 608-ft. steel bridge near Hansen at approx. $92,541.

Ill., Blue Island—Strobel Steel Constr. Co., 50 W. Jackson St., Chicago, award. contr. for construct'g steel r. r. bridges over Calumet-Sag channel, at $20,470.

Ind., Lebanon—Edw. F. Smith, Indianapolis, award. contr. for bldg. following brgs.: Brdg. No. 5, at $1,898; No. 6 at $2,968; No. 7 at $2,240; No. 8, $1,798; No. 13, at $1,048.

Ind., Sullivan—Co. Comn. award. following contracts for bridge construction: D. F. Alumbaugh, Sullivan, for erect. of Marquette brdg., and repair Scottsville brdg., Haddon Twp., at $3,700; T. J. Walls, Farmersburg, for constr. of Stanley, Turman Twp.; Carrithers, Turman; Dix, Turman; Gray, Cass; Everhart, Cass., at $17,496.

Ia., Decorah—E. T. Fowler, Lansing, award. contr. for bldg. bridges, at about $10,000.

Ia., Des Moines—Stark Bridge Co., and Koss Constr. Co., both of Des Moines, award. contracts (equal share) for constr. of 25 bridges and culverts in Polk county at $35,000. Specifs. call for 18 of the 25 bridges to be box culverts, 4 conc. slab brdgs., and 3 conc. deck girder bridges.

Ia., Eldora—Contracts for 10 cem. conc. bridges award. in Hardin Co. as follows: Fifield Constr. Co., Waterloo, Ia., 3 brdgs., at $10,395; Wey-Keller Constr. Co., Waterloo, 2 brdgs., at $6,980; T. J. Wagner Co., Swea City, 5 bridges, at $12,809.

Ia., Mederville—F. E. Marsh & Co., Jefferson, Ia., and C. H. Williamson, Elkader, award. contr. for constructing bridge and culverts at $17,783 and $2,614, respectively.

Mich., Bangor—H. Stewart, 418 Bearinger St. Saginaw, award. contr. for improving Indiantown bridge on Euclid Ave., at abt. $10,000.

Mich., Escanaba—Delta Contracting Co., City, award. contr. for bldg. rein. conc. arch crossing Menominee river in Breitung Twp., Florence and Dickinson counties, consisting of 2 80 ft. spans; one 85-ft. span and approaches with an over all length of 326 ft. etc., at $38,500.

Mich., Florence—Delta Constr. Co., Escanaba, award. contr. to build interstate bridge across Menominee river at Iron Mountain at $38,500.

Mich., Florence—Delta Constr. Co., Escanaba, award. contr. to build interstate bridge across Menominee river at Iron Mountain at $38,500. Bridge will have total length of 836 ft. and will be constructed of conc.

Mich., Lansing—Hicks Engrg. Co., award. contr. for construct'g 350 ft. conc. 3-girder bridge crossing Ruth Lake on Fed. Aid Rd. near Three Lakes, at $4,100.

Mich., Ypsilanti—Heitsch Bros., Pontiac, award. contr. by Ypsilanti & Superior Twps., for rebldg. Peninsular Brdg., at $17,827.

Minn., Worthington—Iowa Bridge Co., 710 McKnight Bldg., Minneapolis, award. contr. for state bridges Nos. 2958 and 2959, Worthington and Noble Cos., for $9,125, plus 15% for taking out old brdg., and maintaining temp. crossings.

Mo., Jefferson City—Pope Constr. Co., Jefferson City, award. contr. for excav., embankment, ditching, graveling, rolling, head walls and pipe culverts, at $4,480.

Mo., Leeds—Pioneer Bridge Co., 514 New York Life Bldg., Kans. City, Mo., award. contr. for constructing rein. conc. bridge with 3 54-ft. span over Blue River on Raytown Rd., at $55,538.

Mo., Neosho—Concrete Steel & Constr. Co., Joplin, Mo., award. contr. to construct 3 50-ft span concrete bridge over Shoal creek; 388 ft. long, 20 ft. wide; 238 ft. earth approach and fill, at $15,800.

Mo., Tipton Ford—Concrete Steel & Constr. Co., Joplin, Mo., award. contr. for constr. of concrete bridge over Shoal Crk., at $15,800.

Neb., Blair—Beaty Constr. Co., City, award. contr. for furnishing material and and constructing 5 rein. conc. arched cem. culverts, at $5,376.

N. J., Medford—Medford Concrete Co., award. contr. for rein. conc. brdg., at $8,575.

N. J. Newton—Franklin Contracting Co., City, award. contr. for constructing steel conc. bridge over Clove Creek in Sussex Boro. on Sect. 2 of Ross Cor.-Sussex Rd., at $5,550.

N. Y., Ogdensburg—Jno. A. Wert, award. contr. for construction of conc. bridge over canal on Main St.; also bldg. of raceway, at $10,466.

N. D., Grand Forks—J. A. Anderson, City, award. contr. for constructing bridges at approx. $30,000.

O., Newark—Illinois Bridge Co., 1623 Monadnock Blk., Chicago, award, contract for constructing Nichols Bridge over Raccoon Crk., St. Albans Twp., at $7,647.

Okla., Hobart—Okla. Bridge Co., Okla. City, award. contr. for constructing conc. bridges and culverts in Kiowa Co., on Ozark Trail and Star Hwys. at $22,200.

Okla., Newcastle—Olson & Magee, Kansas City, Mo., award. contr. by govt. to construct bridge across South Canadian River at $202,800.

Okla., Vinita—Boardman & Co., City, award. contr. for constructing culverts and small bridges in Craig Co., at $6,000; Teener & Armstrong, contract for Elm Crk., White Oak Crk., Bull Crk., and Jones Crk. brdgs.

Ore., Astoria—Jewell Lumber Co., award. contr. for bldg. bridge over Behnke Crk., at Jewell, at $3,621; Portland Brdg. Co., for bldg. brdg. over Skipannon on Warrenton cutoff at $5,077; also for bldg. bridge over Nehalem river near Elsie at $11,100.

Vt., Richford—W. E. Poulin, Merieville, Que., Canada, award. contr. for bldg. rein. conc. brdg. with 2 67-ft. arches betw. here and Sutton, Que., at abt. $24,825. Cost will be borne by state, Richford Twp. and Province of Quebec.

W. Va., Charleston—C. F. Fogle Co., St. Albans, W. Va., award. contr. for masonry work on bridge to be constructed over Coal River at Alum Crk., betw. Kanawha and Lincoln counties; stone piers, at $10,000.

Wn., Colfax—H. C. Mallott, Seattle, award. contr. for constr. of Parvin bridge at $13,995.

Wn., Olympia—Chas. G. Huber, Seattle, award. contr. for new steel brdg. of two 100-ft. spans over Naches river on McClellan Pass hwy., at $26,300.

Wn., Whitman—Mitchell Bros., Paulsen Bldg., Spokane, award. contr. by Colfax Co., for bldg. bridges in connection with road work here, at abt. $13,000.

Wis., Chilton—J. Young & Bro., Oconto, award. contr. for bridges, at $5,466.

PROSPECTIVE WORK

ROADS AND STREETS.

Ala., Florence—$50,000 appropriation made for constr. of new road to connect Florence with Dam No. 2, which is to be topped by a rdway; Gloverdale Rd. will also be extended from Salem Ch. to Tenn. line.

Ala., Montgomery—Bd. of Commrs., Montgomery Co. will improve five miles of Hayneville rd., betw. Cater Mill Rd. and old pike road.

Ariz., Flagstaff—Plans under way for constr. of road from Springerville to Clifton. Estimated distance—95 miles; 16 miles in this county. Approx. cost of road, $550,000.

Ark., Bentonville—Benton Co. Commrs. have plans by State Roads Comn., Little Rock, for constr. of road from Rogers-Monte Ne to Washington Co. line—8 miles macad.; est. cost, $36,008.

Ark., El Dorado—Union Co. Commrs. have plans by State Hwy. Dept., Little Rock, for 20-ft. clay and sand road—El Dorado to county line; est. cost, $60,941.

Ark., Ft. Smith—Sebastian Co. Commrs. considering construction of various roads, including proposed Fort Smith-Greenwood road, $100,000 available.

Ark., Harrisburg—Poinsett Co. Commrs. have plans by State Hwy. Comn. for rd. from Marked Tree Crk., to Crittenden Co. line; 9 mi. long; 9 ft. conc. surface, macad. shoulders 3 ft. wide; est. $253,100.

Ark., Little Rock—Plans sent out by St. Hwy. Dept. for system of roads in Crittenden county (57 miles in length); est. cost $440,000. Roads will be of gravel.

Ark., Little Rock—$62,649 appropriated for No. Ark. Hwy. No. 2 by State Hwy. Comn.—to extend from Batesville to Missouri line via Mammoth Springs route.

Ark., Prescott—Nevada Co. Impvt. Dist., No. 1 (W. W. Rice, Pres.) will construct 20-mile gravel hwy. $80,000 for expenditure. Lund & Hill, engrs., Little Rock, Ark.

Ark., Van Buren—Crawford Co. Commrs. have plans by state hwy dept., Little Rock, for 11-mile macad. rd.—Mulberry to Alma; est. $90,531.

Cal., Long Beach—Proposed hwy. from end of Ocean Ave. across Bascule Brdg., thence over new rd. to So. Western Shipbldg. Co.'s yds. on Terminal Isl., now seems assured. Salt Lake Ry. Co. has agreed to use of Bascule Brdg. for traffic. Cost of planking brdg. and bldg. approaches; also abt. one mile of hwy. is est. at $20,000.

Cal., Marysville—Supvrs. W. J. Mellon of Challenge and Distr. Atty. E. Ray Manwell will act for county in securing right-of-way for rd. through Miner Jane ranch near Camptonville, to be made portion of new hwy. being constructed from Nevada City to Downieville.

Cal., San Bernardino—City contemplates paving E street—9th St. to Highland Ave.; est. cost $35,000. About 7,200 ft.

Cal., Santa Ana—Homer Hamlin, Consit. Engr., has reported against constr. of road along river at Sulphur Slide in Santa Ana canyon, and plans will be prepared for highway on the ridge. Approx. cost $60,000.

Colo., Boulder—Comrs. Boulder Co. contemplate improving South Fork Rd. About $50,000.

Fla., Blountsville—$10,000 bonds voted by Calhoun county for constr. of road from Jackson Co. line to Franklin Co. line, via Altha, Blountstown, Scotts Ferry and Port St. Joe.

Fla., Miami—City soon to ask bids for construction of 22,000 sq. yds. asphalt; 12,000 sq. yds. macad., and 21,000 lin. ft. conc. curb.; $80,000 available. J. C. Hickson, street committeeman; Chas. W. Murray, city engr.

Fla., Miami—City may pave Miami Ave., abt. 10,600 ft., with 4-in. concrete base, at $77,634, or $61,763 without base.

Ida., Coeur d'Alene—Ida. State Hwy. Comn. considering constr. of stand. highway—Fernwood in Benewah Co., to Coeur d'Alene of the east side of Coeur d'Alene Lake, touching St. Maries and Harrison.

Ill., Chicago—Commrs. of Cook County forest preserve district have voted to extend Washington boulevard—Thatcher Ave. across Desplaines River to First Ave., Maywood. Maywood authorities have indicated their readiness to continue drive through their territory. New rd. will be conc., 100 ft. wide with river bridge having 50 ft. rd.-way and 10-ft. walk on either side.

Ia., Waterloo—Construction of road betw. this city and Cedar Falls being considered. Nathan B. Barber, Co. Engr. Black Haw Co.

La., Cameron—Cameron Co. considering construction of 10-mile turnpike hwy.,—Jupiter Point to Johnson Bayou, 20 ft. wide, shell surface. Approx. cost $75,000.

Md., Baltimore—Petition filed with Balt. Co. Commrs. requesting that Willow Spring Ave. at Dundalk be made 70 ft. wide. Est. cost $17,000. U. S. Shipping Bd. is reported in favor of $4,000,000 expendt. in this vicinity.

Mass., Wellesley—Plans under way to pave Washington Ave. Approx. cost, $95,000

Mich., Pontiac—Oakland County's five Covert law roads to be built this year have been approved by the Capital Issues Comm. at Washington. Elizabeth Lake and Royal Oak-Clawson highways sanctioned by the govt.; the 3 others had been approved previously. This means expendt. of nearly half a million dollars for rd. constr.

Minn., St. Paul—Business men will provide necessary funds to complete Concord St. paving (to provide an adequate commer. hwy. betw. this city and South St. Paul). So. St. Paul has $100,000 available; St. Paul will provide $20,000.

Miss., Branson—Rankin County Commrs. will construct 3.83 miles Centennial Hwy., State Aid proj. No. 18. Xavier A. Kramer, State Hwy. Engr., Jackson, Miss.

Miss., Jackson—24 miles of rd. improvement work approved by Fed. Dept. for Itawamba County. Est. cost $130,000. X. A. Kramer, State Hwy. Engr.

Mo., Marshall—Petition bearing 300 names presented to Council requesting election to vote on $700,000 bond issue for constr. of county wide system of roads in Howard County.

Mo., St. Louis—Lemar Ferry and Telegraph roads will be rebuilt from city limits to Jefferson Barracks. Govt. has requested improvement as military necessity; $70,000. Cost will be shared equally by St. Louis Co. and State Hwy. Comr. Work is planned to be done by convict labor.

Mo., St. Louis—Bill authorizing constr. of driveway through Glasgow Tract near Chain of Rocks, has been approved. Est. cost $75,000.

Mo., St. Louis—Ord. introduced to condemn right of way for extension of Skinker rd.—Delmar Blvd. to Olive St. New street will be 80-ft. wide and will include constr. of a viaduct in the shape of letter "X" to proposed jct. of Skinker rd. exten. with Olive St. rd. at Hodiamont Ave.

Mont., Butte—Silver Bow County considering improvt. of all bridges and roads in Glacier National Park. Abt. $80,000 appropriated for project.

Mont., Butte—$400,000 available in Madison County for constr. of highway through Cardwell canyon. It is expected other counties will help in the constr. of this work which will bring Bozeman, Mont., 16 miles nearer to Butte.

Mont., Helena—State Hwy. Comn. will immediately start constr. of 55-mi. hwy. across main range of the Rockies from Glacier Pk. Sta. on East to Belton on the West. Approx. cost $100,000.

Mont., Livingston—$50,000 will be expended by National Park Serv. Board, for bldg. new road in park betw. Mammoth and Gardiner. This will eliminate the dangerous road betw. these two places.

Nev., Reno—Secy. of Agriculture has approved first Washoe county rd. project of Nev. State Hwy. Dept. This covers sect. of Reno-Carson hwy. running from Huffakers to Washoe. $40,977 has been set aside to aid in the constr. and is now available. Hwy. Engr. Cottrell.

N. J., Jersey City—Bids soon to be received for granite blk. and bitum. conc. paving, etc., on boulevard. Est. cost $179,000. Frank A. Dolan, Clk.

N. J., Mays Landing—City considering expendt. of $750,000 for improvt. of roads near munitions factories in Atlantic Co. A. H. Nelson, Atlantic City, Co. Engr.

N. J., Salem—Bd. of Freeholders, Salem Co., are considering bldg. conc. hwy. from entrance of Plant No. 2 of Du Pont Powder Co. at Carney's Point to lower canal bridge —about a mile.

N. M., Santa Fe—Bids soon to be received by State Hwy. Dept., for bldg. roads in various counties: Colfax Co., 68.2 mi. State Rd. 1—abt. $157,900; Mora Co. 15.2 mi. state rd. No. 21, $78,000; Santa Fe Co., 9 mi. rd. No. 1, abt. $27,000, and others. J. A. French, State Hwy. Engr.

N. Y., Syracuse—State Hwy. Dept. has appropriated $43,618 for road constr. in Onondaga Co. Frank E. Bogardus, Co. Supt. of Hwys.

O., Akron—Ord. passed providing for appropriation of $50,000 for paving S. Main St.—Thornton to Crosier St.

O., Bellaire—About 4 miles of road planned near here. Approx. cost $191,000. David C. Kennon, Co. Surv. Belmont Co., St. Clairsville.

O., Cincinnati—Co. Survy. Wm. Boeh has submitted estimate of cost of constructing Brower Rd.—North Bend to Finney and from there to Dugan Gap Road. North Bend to Finney—2.82 miles, $65,703; 4.1 mi. Finney to Dugan Gap Rd., $75,526.

O., Cleveland—Detroit Ave., in Lakewood, will be paved with wood blocks. Paving will extend about 4 miles—W. 117th St. to Rocky River.

O., Lima—State Hwy. Commission has requested passage of final resolutions for improvt. of 11 miles of Dixie hwy. on Lima-Sandusky Rd., also 2½ mi. of Lincoln hwy. on Lima-Kalida Rd. Comn. and County will each pay $1,000 per mile for this work —abt. $30,000 being expended for the improvt.

O., Lorain—City has been requested to spend $120,000 to provide paved streets and sewers for 200 homes for workers in shipbldg. district.

O., Madison—No bids being received for paving N. Ridge Rd. through Madison and Perry Twps., and part of Painesville Twp., new estimates will be made and bids again called for. In Painesville and Perry Twps. there is a total of 7.715 mi.; in Madison Twp. entire dist. 5.433 mi.

O., Port Clinton—Camp Perry road—this city to the camp—will be rebuilt at expense of State Hwy. Dept. Road is used daily by large army trucks for conveying heavy materials.

O., Portsmouth—Within 60 days work is expected to begin on state aid hwy. from this city to Cincinnati. Limestone filler may be used in road bed. Co. Survyr. Jno. Harper, has been authorized to make survey for 60-ft. road from this city to the Turkey Crk. rd. which runs into West Union.

O., Youngstown—Property owners must decide whether Federal Street will be widened or not. Offer made by Chicago concern to purchase the bonds amounting to $350,000.

O., Youngstown—Bureau of Public Rds., Washington. D. C., has approved bond issue of $132,000 for good roads in Mahoning County.

Ore., Klamath Falls—House of Representatives voted $50,000 for roads in Crater Lake National Park.

Ore., McMinnville—State Hwy. Comn. has begun survey of rd.—Neskowin, running up stream, crossing summit and then down to Salmon River.

Ore., Portland—State Hwy. Comn. will ask permission of Capital Issues Com. for authority to issue $583,700 road bonds, which is estimated amount of cost of surfacing sects. of two main state hwys.—Pacific and Columbia River.

Ore., Salem—Bids soon to be asked for paving 18 mi. of Pacific Hwy.—Aurora to Salem. Est. $348,000—state to pay half the expense.

Pa., Germantown—Comm. on Hwys. has approved bill to pave following sts. with asph. and brick gutters: Portion of Apsley St., Berkley, Blakemore, Crowson, Hortter Sts., Roberts Ave. Provision also made for paving Church lane with granite blocks —Germantown to Bellfield Ave.; and Benezt St.—Chestnut Hill with macad. Bill also introduced by Councilman Pringle Borthwick to repave Chelton Ave. with vitr. brick—Wayne to Pulaski Ave. Bill approved to grade Greene St.—Upsal to Carpenter St., and Phil-Ellena St.—Sherman to Arbutus.

Pa., Philadelphia—County Bd. of Freeholders have received permission from State Hwy. Comn. to take over paving of White Horse pike. Steps will be taken immediately to authorize expendt. of $750,000 on basis of $45,000 per mile, for paving that portion of direct motor route from Phila. to shore betw. Camden County line and Elwood.

S. D., Custer—Among the government good road projects in Black Hills Forest is the constr. of a highway from McCoff ranch on Bear Butte Crk. to point 3.12 miles distant. Est. cost $30,350.

Texas—Following counties will be given state aid: Van Zandt County sum of $12,415 to be expended on hwy. No. 15 betw. Edom and Smith Co. line; also $8,311 on Hwy. No. 19—Martins Mill and 6 miles north of said point; Brazos Co., $37,852 in Zilliken District; El Paso County, $50,000 on sect. of Hwy. No. 1 east of El Paso, and $10,000 on section west of El Paso; Travis County's former allotment of $12,500 will be increased to $18,784 on Hwy. No. 2—Austin to Pflugerville.

Tex., Hillsboro—Elec. to be held July 27 to vote on $2,500,000 bond issue for purpose of constructing sys. of perm. hwys. in every section of Hill county.

Utah, Salt Lake City—State Hwy. Comn. considering constr. of 45-mile road, Orangeville, Emery Co., to Ephraim, Sanpete Co. Est. cost about $150,000. E. E. Kidder, State Hwy. Engr.

Va., Newport News—City considering expenditure of $50,000 (with like amt. from Government) to extend military highways. T. E. Pearse, City Engr.

Va., Richmond—Resolution adopted by Council to appoint special committee to cooperate with state council of defense in securing federal aid for constr. of hwy. sys. betw. this city, Washington, Norfolk and Newport News.

Wash., Chehalis—State Hwy. Commissioner Allen has included in his budget, appropriations for following highways: $90,000 for rd.—Jackson Prairie to Silver Creek; $30,000 on Park Hwy.—Eli to Walville; $40,000 for State Rd. No. 5—Kosmos to Randle; $70,000 for Pacific Hwy.—to complete paving link betw. Chehalis and Toledo.

W. Va., Moundsville—Marshall Co. considering repaving & regrading 1.3 miles of Narrow road; also widening same in various places. Est. cost abt. $50,000.

W. Va., Wayne Co. (P. O. Wayne)—$1,000,000 road bonds, recently voted, have been approved by Atty.-General.

SEWERAGE AND SEWAGE TREATMENT

Ariz., Glendale—City contemplates bldg. 40,000 lin. ft. 6-8 and 10 inch sewers, 64 manholes, 26 flush tanks, etc. Abt. $35,000.

Ark., Waldron—O'Neil Engrg. Co., 1505 Praetorian Bldg., Dallas, has been retained by city to prepare plans for sewer and water works constr. Est. cost $45,000.

Cal., Holtville—City contemplates bldg. outfall sewer to Alamo River.

Cal., Los Angeles—City Engr. instructed to prepare Ord. for sewering 13th St.—Faggey St. to Cabrillo St., San Pedro; also for sewers in Savannah St. Ord. also adopted for constr. of sewer in Denison Ave. Sewer Dist., San Pedro.

Cal., Los Angeles—Plans prepared by City Engineer's Dept. for constr. of an elaborate sewage disposal system for portions of Wilmington and Terminal island. Plans call for expendt. of $135,000 for bldg. pumping plants in W. Wilmington near site of So. Cal. Shipbldg. Co., on Mormon Island and in Terminal Island; also constr. of sludge beds and tanks just east of Fish

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Harbor. Sewage is to be dumped across the channels in the inner harbor—force main crossing channels to cost $60,000.

Cal., Los Angeles—City Atty. authorized to proceed with condemnation proceedings necessary for sewer right-of-way at east end of Eastside Blvd.

Cal., Newport Beach—City has had plans prepared by P. E. Kressly, City Engr., for sewer sys. and sewage disposal plant. Abt. $110,000. Septic tanks also to be installed.

Cal., Porterville — Plans submitted by City Engr. Fred Pease for sewer mains to be laid in district west of Baker St., to serve newly opened Park View tract.

Cal., Stockton—City soon to receive bids for bldg. 2 sewage disp. plants, 1 for northern and 1 for southern sections of city. F. H. Tibbitts, Engr., Alaska Commercial Bldg., San Francisco.

Cal., Turlock—Plans prepared for construction of sewage treat. plant & 6-mile outfall sewer.

Ga., S. W. La Grange (P. O. La Grange)—Town will vote July 24th on issuance of $63,000 bonds for construction of sewer system. C. A. Coleman, Mayor.

Ida., Montpelier—Council plans to issue $36,000 bonds for constr. of sewers in Distr. No. 1. T. Barrett, Clk.

Ill., Mendota—City soon to let contract for bldg. sewerage system. Abt. $70,000. W. Duetchler, City Engr.

Ill., Mt. Olive—City considering installation of sewer system that will take in greater part of town. Est. cost $80,000.

Fla., Leesburg—City Engr. Francesca has been authorized to prepare specifications for sewers. W. H. Porter, City Clerk.

Fla., Miami—$175,000 bonds voted for various improvements, including $65,000 for sewer construction.

Fla., Pensacola—City Commrs. considering constr. of sewer system and probably disposal plant.

Ga., Macon—Ord. passed to call elec. to vote on issuance of $55,000 bond for purpose of bldg. & extending sys. of surface or storm and san. sewers.

Kan., Wichita—Capital Issues Comm. has given city permission to issue $175,000 storm sewer bonds.

La., Alexandria—War Dept., Washington, D. C., will construct sewer sys. at Camp Beauregard; $480,000. Capt. J. J. McConnell in charge.

Mich., Muskegon—City Engr. C. L. Nelson has presented to Council estimates of cost for proposed sewer district; $27,687. Greatest cost in estimate is for 10,700 ft. tile pipe at $19,700. Other items are 3,132 ft. 24-in. tile at $9,396; 25 manholes at $2,000.

Mo., Springfield—City considering constr. of sewer sys. in Phelps Grove Park. Wk. involves 1 mile 12-in. sewers and laterals. O. D. Chrisman, City Engr.

Neb., Humphrey—Bids to be asked in near future for constr. of sewer system. W. E. Standeven, Omaha, Engr., has prepared plans.

N. J., Dover—Sewerage Comn., recently appointed, will take up bldg. of sewerage system to connect with proposed Jersey City trunk line to protect the Rockaway River from contamination. Voters, however, must first ratify bond issue proposal.

N. J., Haledon—Boro. has retained H. J. Harder, Engr., Paterson, N. J., to prepare plans for sewerage system and sewage disposal plant.

N. J., Morristown—Town conemplates constr. of sewerage system, 1 sty. 12x25 ft. brk. valve house, 3 sand filters; 2,000 ft. 18-in. tile. Est. cost $25,000. P. S. Pierson, Trust Co. Bldg., Town Engr.

N. M., Deming—Major Frederick P. Simonds, Q. M., has received instructions from Washington to prepare for installation of complete sewer sys. Est. cost, $500,000.

N. Y., New York—Contr. soon to be let for bldg. sewer in Schofield St.—City Island Ave. to bulkhead on Long Isl. Sound. Abt. $15,000. A. Lewis, Ch. Engr., Boro. Hall, Tremont Ave.

N. Y., New York—Sewer Bureau has completed plans for important trunk sewer in Laurel Hill section in vicinity of large plants taken over by government. Plans will be rushed through Board of Estimate.

O., Akron—Recommendation made by H. S. Morse, Secy.-Direct., and E. Jeisloft, City Engr., to construct five ft. trunk sewer one mile long, connecting sewers through 20 blocks, E. Akron.

O., Bowling Green—Ord. passed to proceed with constr. of lateral san. sewer on Pearl St.—Buttonwood to Grove Sts. City also considering construction of san. sewer on Thurstin Ave., with lateral sewers on Virginia and Holmes Sts., at $5,423.

O., Canton—In order to make all additions to sewage plant that are necessary, it will cost approx. $113,000.

O., Canton—Ord. passed to issue bonds in sum of $60,000 for purpose of constructing storm water sewers in various streets. W. Edgar Jackson, Clk.

O., Lancaster—Plans, specifs., etc., of So. Lancaster sewer and sewer Dist. 13, by Engr. Graf, have been approved. Ord. also passed to constr. sewer on West Side in Sewer Distr. No. 5.

O., Lima—Geo. W. Fuller, Expert Engr., New York City, will draft plans for new trunk and relief sewer. It is expected the new sewers will cost approx. $900,000.

O., Mansfield—Ord. passed authorizing issuance and sale of $20,000 bonds for constr. of various storm water sewers in city.

Okla., Okmulgee—No bids being received for constr. of sewers in Distrs. 27 and 28, Board of Commrs. has ordered estimates revised and increased. Bids will again be called for.

Okla., Tulsa—City considering bldg. storm and san. sewers in W. Tulsa, $15,000, and in Kendall, $48,000. H. H. Wyse, City Engr.

Pa., Farrell—Estimated cost of enclosing Haywood sewer to meet Shenango sewer. $75,000.

Pa., Philadelphia — Council's finance comm. has approved transfer of $388,000 of loan funds for extension of Packer street sewer west of Broad St.

Pa., Upper Darby—Vote cast in favor of issuing $120,000 sewage disposal plant, also road and bridge bonds.

Tex., Austin—$100,000 bonds voted to build sewage disp. plant. A. P. Wooldridge, Mayor.

Tex., Del Rio—City will build sewer sys. Est. cost $50,000. O'Neil Engr'g Co., 1505 Praetorian Bldg., Dallas, Engineers.

Tex., Waco—City has revised plans for extension of sewer sys., and construction of sewage disposal plant calling for expenditure of $552,000, instead of $225,000—amt. of bonds voted in Jan. New plans provide for larger disposal plant than at first contemplated, and further sewer extensions to connect with Camp MacArthur. City will vote on additional bond issue of $327,600.

Wis., Beloit—City contemplates installation of $7,000 temporary west side storm water sewerage system.

Wis., Kenosha—Council considering petition for constr. of sewer in Ann St., Edward and Pleasant Prairie; also lowering sewer in Howland Ave.

Wyo., Manville—Town Council soon to award. contr. for bldg. abt. 1½ mi. of new sewer sys. within town limits. Est. cost $15,000 to $17,000. Work involves furnishing and installing 600 8-in. wyes, 8,770 ft. 8-12 in. vitr. salt glazed sewer pipe, 2 flush tanks complete, 24 manholes, purification plant, etc. C. C. Carlisle, 1st Natl. Bank Bldg., Cheyenne, Engr.

WATER SUPPLY AND PURIFICATION.

Ark., Waldron—City will construct waterworks and sewers at cost of $45,000. O'Neil Engineering Co., 1506 Praetorian Bldg., Dallas, Tex.

Cal., Corcoran—$70,000 bonds voted for purchase of water system. Plans include drilling well and installing steel tank and distribution system. M. Stone, City Engr.

Cal., Los Angeles—City contemplates laying water mains in Marine, Island Neptune, Bay View, McDonald, Gulf, King, Hawaiian, Mar Vista and Frigate Aves., also Wilmington Blvd. A. C. Hansen, City Engr.

Cal., Palo Alto—City will purchase 40 service meters, one large flow meter and put in 40 service connections. J. F. Bixby, Jr., City Engr.

Colo., Canon City—G. H. Sethman, Engr., 249 Equitable Bldg., Denver, retained by city to prepare plans for waterworks improvements.

Conn., New Britain—Board of Water Commrs. considering constr. of tunnel to connect Whigville and Burlington water supplies. Est. $325,000.

Fla., Pensacola—Pensacola Navy Yard will build extension of 8-in. water main. Approx. cost $13,800.

Ill., Joliet—Resolution adopted for constr. of water main with service pipes, fire hydrants, valves, valve manholes and specials on Collins St., 34 ft. so. of no. line of Meeker Ave., northerly to 317 ft. no of north line of Williamson Ave. Est. cost $2,413. City also contemplates constr. of water main on Park Ave., Columbia St. and Elwood. Approx. cost $16,981.

Ill., Kankakee—$75,000 bonds voted for extension of Jacksonville water system, and constr. of additional reservoir.

Ind., Gary—Appropriation made by Illinois Steel Co., for immense addn. to Gary heat, light and water plant. Gas holder costing abt. $290,000 will be constructed and miles of new mains laid.

Kans., Moran—City contemplates improving waterworks system to include engine and generator set. Abt. $10,000. W. E. Young, Clerk.

La., Alexandria—War Dept., Washington, will increase water supply at Camp Beauregard; drill 2 addl. wells, making supply 1,250,000 gals. per 24 hrs. Capt. J. J. McConnell, in charge.

Me., Kittery—$200,000 bond issue will be authorized by Kittery Water District for addns. and improvements consisting of two new dams, 2 mi. of 16-in. and 7 mi. of 12-in. mains.

Mass., Erving—Plans for waterworks being prepared by Allen Haywood, Greenfield, Mass. Conc. reservoir with 3,000,000 gal. capy., 1½ mi. of 10-in. wood pipe, 2,500 ft. 6-in. wood pipe, 10 2-way hydrants, 6 in.; 5 6-in. gates, 2 10-in. gates and 100 service connections.

Mass., Sturbridge—City considering installation of waterworks system to cost abt. $30,000.

Mich., Cassopolis—Village contemplates improving waterworks. Work involves 80,000-gal. steel tank, one 350-gal. motor driv. centrif. pump, 1 750-gal. chlorinating apparatus. Holland, Ackerman & Holland, Engrs., 122 4th Ave., Ann Arbor.

Minn., Foley—Plans being prepared for waterworks system to include installation of deep well, 60,000-gal. steel tank pump with 1,000 gpm. motor. G. E. Rice, Mayor.

Minn., Forest Lake—Plans being prepared for village for waterworks system. Approx. cost $30,000. J. F. Druar, 312 Commercial Bldg., St. Paul, Minn, Engineer.

Neb., Collegeview—$10,000 bond issue authorized for waterworks extensions and improvements.

N. J., Boonton — $170,000 bonds sold. Funds will be used to purchase and improve plant of United Water Supply Co. J. B. Hawley, Engr.

N. J., Cape May—Plans drawn for water tank and tower for U. S. Govt. Navy Dept., $45,000. C. W. Parks, Ch. Bureau Yds. & Docks, Wash, D. C.

N. J., Trenton—City considering installation of two pumps with generators. Approx. cost $100,000.

N. Y., Peekskill—Village plans to install complete new pumping apparatus. H. W. Taylor, 26 Cortlandt St., N. Y. City, Consit. Engr.

O., Barberton—Service Director Seiberling recommends appropriation of $20,000 for extension of water mains. This is one of the most urgent needs of the city.

O., Bryan—$90,000 bonds voted for purpose of enlarging municipal light, power and water plant.

O., Cleveland—Ord. passed to issue bonds to amt. of $500,000 for purpose of securing right-of-way and erecting waterworks; also extending, enlarging, improving same, etc. C. J. Benkoski, Clerk.

O., Elyria—If suggestions made by City Engr. Wm. G. Clark are carried out, it will cost city $750,000 to improve waterworks pumping station. He recommends that either a 30 or 36-in. main be laid betw. city and pumping station, say 3 miles at a time, at cost of $310,000 for 30-in., and $420,000 for 36-in.; new pumps, boilers, filter equip., etc., will cost abt. $332,000.

O., Elyria—Levels being secured along Murray Ridge to determine feasibility of install'g nuge reservoir near city—storage plant to be extension of present waterworks system.

Okla., Lawton—Filtration plant will be constructed here, in connection with Lawton sys. of waterworks. $100,000 appropriation.

Okla., Poteau—$95,000 voted for waterworks improvements: comb. filtr. & purification plant, 1¼ miles from city—capy. 500,000 gals. daily. Plans not yet submitted. Will also install machinery. Est. cost $60,000. Henry A. Pressey, Engr., N. Y.

Ore., Portland—City considering following water works construction this year: 1,500 ft. 24 in. c. i. pipe, 14,000 ft. 12 in., 8,000 ft. 8 in., 6,000 ft. 6 in. and 25,000 ft. 2 in—the last named galv. iron pipe. A. L. Barbur, Comr. Public Wks.; C. Laungaard, City Engr.

Pa., Sharon—Sharon Waterwks. Company considering important improvements. Planning lay 24-in. mains and to install 20,000,000 gal. pumping unit. Est. cost of work—$500,000 to $750,000.

S. C., Charleston—Board of Pub. Wks. contemplate increasing daily water supply from 7,000,000 to 12,000,000 gals.

S. D., Watertown—City contemplates purch. of water works sys. of Watertown

Water Co. Among improvements recommended are: modern filtr. plant and sterilization equipment; new pump, new standpipe; together with extensions to mains. Total cost of purch. & improvements $266,719. Burns & McDonnell, Consulting Engrs., Kans. City, Mo.

Tex., San Angelo—Recommendation made by V. M. Ehlers, State San. Engr. at be constructed here at or near filter plant.

Tex., Waco—Mammoth settling basin to be constructed here at o rnear filter plant. Est. cost $15,000. Capy. 5,000,000 gals.

Va., Alexandria—Alexandria Water Co., contemplates installing filtration plan. Est. cost bet. $50,000 and $60,000.

Va., Portsmouth—Portsmouth, Berkley and Suffolk Water Co. considering improvements to water works, including installation of meters. Est. cost $250,000.

Wn., Bellingham—On account of difficulty in securing bids for laying new 48-in. main City Engr. Adams suggests that a conc. easement be placed around the present water main from Lake Whatcom.

Wn., Chehalis—City will put in approx. 20 house connections and 5 water meters. W. G. Peters, City Engr.

Wis., W. Allis—Plans being prepared for water mains to connect with Milwaukee water main on Arnold Ave. in W. Milwaukee. City Engr. Orbert.

W. Va., Clarksburg—City has requested permission of Federal authorities at Washington to issue $600,000 bonds for water works and street improvements.

BRIDGES AND BUILDINGS.

Ariz., Flagstaff—Little Colorado brdg. will be constructed at cost of $45,000.

Cal., Marysville—Western Pacific has been granted permission by State Reclamation Bd., to reconstruct portion of railroad bridge across south channel of Yuba River below Marysville.

Cal., Ventura—Co. Engr. Petit has prepared plans for bridge over Coyote Creek in Foster Park. Est. cost $11,000.

Cal., San Jose—Plans being prepared for bldg. rein. conc. bridge over Alamitos Creek on Alamitos Road. Bd. Supvrs. Santa Clara Co.

Cal., Woodland—(Yolo County). Plans being prepared by A. G. Proctor for construction of bridge to span Stevens Creek—300 feet. Approx. cost $20,000.

Ga., Macon—Fed. authorities have approved project of Georgia Hwy. Comn., for constr. of steel bridge over Flint river, Macon Co. New bridge will extend from Montezuma to Oglethorpe. Approx. cost $130,000, expense to be shared equally by Government and Macon Co.

Fla., Miami—$30,000 bonds voted to construct bridge over Miami River at Avenue D; also $10,000 to construct bridge over Miami River at 12th St.

Ind., Terre Haute—City contemplates constr. of National Rd. Brdg. in Lost Creek Twp. Abt. $20,960. H. C. Anderson, Eng.

Kans., Eudora—Commrs. of Douglas and Leavenworth Counties considering bldg. permanent bridge over Kansas River here.

La., New Orleans—Public Belt Railway Comm. considering constr. of brdg. or tunnel across Miss. River. $75,000 expenditures for preliminary investigations, engrg. advice, etc. Advisory Board: J. A. L. Waddell, Kans. City, Mo.; J. Vipond Davies, N. Y.; J. Bien Arnold, Chicago; A. F. Barclay, Engr., of Comn., New Orleans.

Me., Augusta—Skunk Hill bridge in South Portland will be rebuilt—increasing width to 38 ft., and providing widewalk on one side. Approx. cost $25,000; 10% of which will be paid by Cumberland Co. Power & Light Co.

Md., Annapolis—Co. Engr. Hayman instructed by Co. Commrs .to obtain permission from Washington to construct proposed addn. structure, to cross river at Riverview.

Md., Towson—Baltimore County Commissioners will soon ask bids for 47 re-in. conc. bridges 6 to 24-ft. spans. Wm. G. Sucro, Rd. Engr.

Mich., Battle Creek—Plans under way for constr. of bridge over Kalamazoo river coming into Springfield suburb at 20th St.

Mich., Detroit—Mich. Central Engrs. have asked War Dept., through Col. F. W. Alstaetter, U. S. Engr., to construct bridge across River Rouge betw. Dearborn Rd. and Dearborn Ave. This would relieve congestion betw. Detroit and Toledo. Est. cost abt. $500,000. Structure will be cantilever type, 125 ft. high.

Mich., Traverse City—City will have to expend approx. $20,000 to improve concrete bridges and culverts over Asylum Creek, which were built too high and too narrow.

Minn., Duluth—Revised bridge plans approved for new Fond du Lac brdg. to be built across St. Louis river to connect Carlton and St. Louis Cos.

Mo., St. Louis—Bd. Pub. Service applied to Bd. Aldermen to appropriate $41,018 to complete and maintain municipal bridge over Miss. River. W. T. Findlay, Secy.

Mont., Billings—Bd. Co. Comrs. have received petition for bridge over Yellowstone at Waco.

Mont., Columbia Falls—Chamber of Commerce here requested by North Fork settlers to aid them to obtain erection of bridge over North Fork river at Round Prairie. Unless bridge is constructed many settlers will give up their claims, there being no means of outlet from their sect. except by ford over the river which is open only three or four months throughout the year.

Mont., Livingston—County bridges damaged by recent floods will be repaired; among the first being the Harvat and Lamartine bridges. Est. amount of damage about $75,000. County has available funds for repairs.

Neb., N. Platte—$30,000 bridge bonds voted. Funds will be used to build bridge over Platte River. R. L. Cochran, Surv. Lincoln Co.

N. Y., Queens, New York—Six new bridges will be required in constr. of proposed Cross-Bay Blvd. over Jamaica Bay in Queens. 1st will be fixed brdg. over main channel of Bay so. of Howard estates; 2nd will be southward abt. two-thirds of dist. across the bay (lift or swing brdg.); 3rd brdg. betw. 1st and second Islands over Goose Crk. (Fixed struct.); 4th fixed brdg. betw. 2nd and 3rd Islands at the Raunt; 5th brdg. will be adjacent to the bulkhead of South Island and will be fixed structure; 6th over Beach Channel (swing). Bridges will be full width of boulevard—100 ft. with both drways for autos & other vehicles; also side-paths for foot passengers. Est. cost $100,000.

N. Y., Watertown—Election to be held to vote on $90,000 bond issue for construction of bridge across Black river at Diamond Island.

N. Y., New York—Construction of bridge across upper mouth of East River, being considered. Structure to run from Whitestone Ave., Beechhurst to Ferris Ave., Hunt's Point.

N. C., Severn—Bids to be asked in near future for constr. of conc. brdg. betw. this city and Boykins, Va.

N. D., Minot—Bd Co. Commrs. have ordered constr. of rein. conc. brdg. across Mouse River—Fourth Ave., S., E., into Eastwood park on Ninth St., SE. Co. Surv., H. S. Frahm, authorized to prepare plans and specifications.

Cal., Sacramento—Sacramento County considering constr. of 300 ft. rein. conc. bridge over Stevens Creek, Est. cost abt. $80,000. A. G. Proctor, Co. Surv.

O., Lima—Ord. passed by City Council to isuance Ottawa River Brdg. bonds in amt. of $13,000.

O., Toledo—$11,000 bond issue approved by Commrs., for improvement of various bridges and culverts. Two bridges on roads leading to new fair grounds will be reconstructed.

Pa., Harrisburg—Reading Ry., has submitted to City Engr. Cowden plans for proposed rein. conc. bridge to replace present steel structure across Susquehanna River, with request that drawings be approved by Council. Est. cost of bridge $2,000,000. Structure will be abt. one mile long across Front St. Park, Front and Second Sts., and tracks of Penn. R. R.

Pa., Philadelphia—Following construction work being considered: Four groups of engineers have inspected old bridge on lower Schuylkill to see if new structure could be built and traffic maintained during constr. All have reported in the negative. Plans now being considered which call for shift in location of the new Penrose Ave.; change in city plan of that section and constr. of new bridge abt. quarter of a mile further north with westward approach across meadow lands which will require bldg of embanked rdway abt. one mile in length. $278,000 available to begin constr. of abutments for new bridge.

Pa., Point Marion—Construction of bridge over Monongahela River being considered.

Pa., Chambersburg—Preliminary plans for bridge over Falling Spring in W. King St., approved by Co. Commrs., Boro. Council & Chambersburg Woolen Co. Bids will be asked in near future.

S. C., Columbia—State Hwy. Comn. has approved seven additional Fed. aid projects, including constr. of bridge across Broad River at Lockhart, costing approx. $22,434. F. H. Murray, Acting State Hwy. Engr..

What Charles E. Hughes Thinks of the Zone System of Postal Rates.

"I have no hesitation in saying that I regard the zone system of postal rates for newspapers and periodicals, coming under the definition of second-class mail matter, as ill advised. The Commission on Second-Class Mail Matter (appointed in 1911), of which I was a member, considered this question and reported unanimously against the zone system. We said in that report:

" 'The policy of zone rates was pursued in the earlier history of our postoffice and has been given up in favor of a uniform rate in view of the larger interest of the nation as a whole. It would seem to the Commission to be entirely impracticable to attempt to establish a system of zone rates for second-class matter. * * *

" 'Progress in the postoffice, with respect, both to economy in administration and to public convenience, leads away from a variety of differential charges to uniform rates and broad classifications.'

"In my judgment the zone system for second-class mail matter is unjust to the publisher and unjust to the public. It not only imposes upon the publisher the additional rates upon a sectional basis, but it makes necessary the added expense for the necessary zone classifications at a time when every economy in production and distribution is most important. It introduces a complicated postal system to the inconvenience of the publisher and public when there should be a constant effort toward greater simplicity. There is no more reason for a zone system of rates for newspapers and magazines than for letters.

"Newspapers and magazines are admitted to the second-class postal rates on the well established policy of encouraging the dissemination of intelligence, but a zone system is a barrier to this dissemination. If it is important that newspapers and magazines should be circulated, it is equally important that there should be no sectional divisons to impede their general circulation through the entire country.

"We are proud at this moment of our united purpose, but if we are to continue as a people to cherish united purposes and to maintain our essential unity as a nation, we must foster the influences that promote unity. The greatest of these influences, perhaps, is the spread of intelligence diffused by newspapers and periodical literature. Abuses in connection with second-class mail matter will not be cured by a zone system of rates. That will hurt the good no less than the bad, and perhaps some of the best sort of periodical literature will be hit the hardest.

"We do not wish to promote sectionalism, and 'one country' means that in our correspondence and in the diffusion of necessary intelligence we should have a uniform postal rate for the entire country. The widest and freest interchange is the soundest public policy.

"I hope that Congress will repeal the provision for the zone system which is decidedly a looking-backward and walking-backward measure."

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INDIANAPOLIS, IND.

WANTED.

To buy a small iron and wood-working plant, preferably making farm machinery, in small town, with plenty of land for expansion. Address Box 1, Municipal Engineering, 538 S. Clark St., Chicago.

Bids received until August 8, 1918.

SYSTEM OF SANITARY SEWERS.

Garner, Iowa.

Sealed proposals will be reecived by the Town Clerk in his office in the Town Hall until 2:30 p. m., August 8, 1918, for constructing a system of sanitary sewers and a sewage disposal plant.

Section A. Disposal Plant, Concrete Tank, Sand Filters, Sludge Bed.

Section B. Outlet main sewer. 3,750 lineal ft. of 18-in. pipe. 6 manholes.

Section C. Lateral sewers.

1,320 ft. of 18-in. pipe.
2,952 ft. of 15-in. pipe.
3,400 ft. of 12-in. pipe.
3,827 ft. of 10-in. pipe.
24,185 ft. of 8-in. pipe.
80 manholes.
24 flush tanks.

Certified check required, $1,000.00.

Arangements may be made with local banks for cash on each section as completed. Plans, specifications, and forms on file with the Town Clerk or the Town Engineer.

H. V. REED, Town Clerk.
J. G. THORNE, Town Engineer
317 Howes Block, Clinton, Iowa.

Bids received until August 8, 1918.

SEWAGE TREATMENT PLANT AND SEWAGE COLLECTING LINES

Waco, Texas.

Sealed bids will be received until 10 a. m., August 8th, 1918, addressed to John C. Davis, City Secretary of the City of Waco, Texas, for furnishing all labor and material for the construction of a Sewage Disposal Plant, Imhoff-Sprinkling System with a capacity of seven million gallons per day, and for the construction of about eight miles of twelve, fifteen and eighteen-inch vitrified clay sanitary sewers and about two miles of forty-two and forty-eight-inch concrete sanitary sewers.

Plans and specifications now on file in office of Rollen J. Windrow, City Engineer, and in office of P. Trevino, Consulting Engineer, at City Hall, Waco, Texas.

Deposit of fifteen dollars ($15.00) is required for each set of plans and specifications furnished to bidder.

A certified check for Ten Thousand Dollars ($10,000.00) on a local bank shall accompany each bid on the Sewage Disposal Plant and a certified check for Seven Thousand Five Hundred Dollars ($7,500.00) on a local bank shall accompany each bid on sewers guaranteeing the signing of contract and execution of required bond.

The City reserves the right to reject any or all bids.

Bids received until August 9, 1918.

STREET PAVING

Cass Lake, Minn.

Notice is hereby given, that sealed bids will be received for the construction in the Village of Cass Lake, in the County of Cass, State of Minnesota, of certain pavement in the streets and avenues of said Village as follows: On Second Street North from the easterly line of First Avenue West to the westerly line of Third Avenue West; thence down said Third Avenue West, south, from the southerly line of Second Street North to the southerly line of First Street North; thence west on First Street North from the westerly line of Third Avenue West to the westerly line of Fourth Avenue West; from the westerly line of Third Avenue West on Second Street North to the westerly line of Fourth Avenue West, all according to plans and specifications therefor now prepared and on file in the office of the Village Clerk of said Village.

Said bids to be upon a basis of cash payment for said work, and all of said bids will be opened and considered by the Council of said Village at the hour of eight o'clock p. m. on the ninth day of August, 1918. No bids will be considered unless sealed and filed with the Clerk of said Village prior to said time and accompanied by a cash deposit or certified check payable to the Clerk of said Village for at least ten (10) per cent of the amount of such bid. The right is reserved to reject any and all bids.

Dated July 13, 1918.

A. F. ITTNER,
Village Clerk, Village of Cass Lake, Cass County, Minnesota.

Bids received until August 5, 1918.

FOND DU LAC CONCRETE ARCH BRIDGE

Duluth, Minn.

Sealed proposals for the construction of a concrete arch bridge herein described will be received by the County Auditor of St. Louis County, Minn., at his office in the Court House, City of Duluth, up to 12 o'clock noon of Monday, 5th day of August, 1918. Bids will be publicly opened at 1:30 p. m., on the same day and contract awarded as soon thereafter as possible.

The proposed structure consists of a five-span reinforced concrete arch bridge of the earth filled type with approach spans. The five main arches are 116 feet clear span with a roadway 20 feet wide, and one sidewalk 4½ ft. wide. The approaches consist of two "U" abutments and one 40-foot arch, the total length of the bridge being 740 feet.

Proposals, plans and specifications may be obtained after July 10th at the office of the County Auditor, upon deposit of ten ($10.00) dollars, which amount will be refunded upon return of the plans and specifications in good condition.

Proposals for this contract should be addressed to the County Commissioners of St. Louis County and enclosed in an envelope marked "Proposal," for constructing reinforced concrete arch bridge over St. Louis River, from a point in its suburb of Fond du Lac, Duluth, Minn., to a point in the County of Douglas, Wisconsin.

Each proposal must be accompanied by cash or certified check payable to the order of the County Treasurer, St. Louis County, for an amount equal to at least ten per cent (10%) of the amount of the proposal. The successful bidder must furnish bond in an amount equal to the price of the work.

The County Commissioners reserve the right to reject any or all bids.

O. HALDEN,
Auditor, St. Louis County.
By J. O. WALKER,
Deputy Auditor.

Bids received until August 6, 1918.

BRIDGE CONSTRUCTION.

Sealed proposals will be received up to 11:00 A.M. August 6, 1918, for furnishing materials and constructing a bridge over Flint River, between Oglethorpe and Montezuma, on the Dixie Highway, between Macon and Thomasville.

Contract No. 1 consists of three steel spans 120 feet long, 630 cubic yards reinforced concrete, 3600 linear feet wood piling for foundations.

Contract No. 2 consists of 1540 linear feet of concrete approaches, 2629 cubic yards reinforced; 467,318 pounds of steel, 4000 linear feet wood piles for foundations.

Bidders can bid on either the one or the other or both contracts.

The quantities are approximated.

MACON COUNTY GEORGIA.
By A. H. PERRY,
Clerk County Commrs, Macon County, Ga.
GARRETT & SLACK, Engineers,
Montgomery, Ala.

Copy for Official Proposal Advertisements

for any issue received until the 22d of the month preceding date of issue.

All proposals on road or street work, water works, sewers, refuse disposal, drainage and irrigation, bridges and public buildings should be published in this magazine. Its large circulation among contractors will insure the widest competition and the lowest bids.

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(built in 1905)
Still in Operation

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The Merriman Steam Melting Plants are built as one car; Road Asphalt and Stationary Plants.

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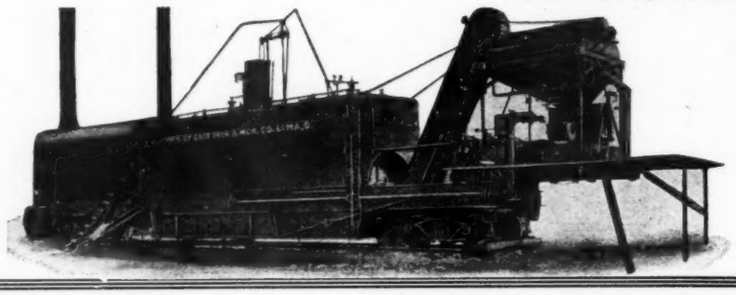
W. N. Andrews, President.



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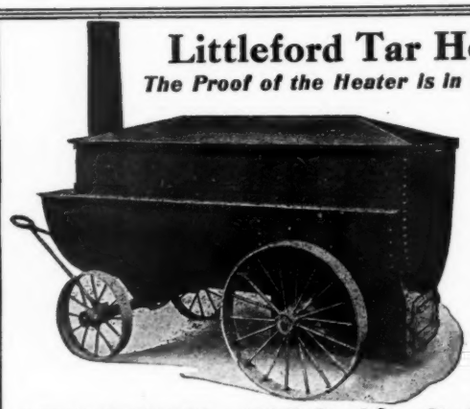

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There exists, at this time, urgent need of men who have experience in the following trades:

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Helper—Harness Maker	Magneto Repairer	Painter	Wheelwright

Any man, whether of draft age or not, who has had experience along the lines enumerated, is requested to write without delay to the Commanding Officer, Quartermaster Mechanical Repair Shop No. 304, Fort Sam Houston, Texas, who will furnish full particulars concerning pay, government allowances and opportunities that are open to men possessing the qualifications making them desirable for duty in this organization.

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Rosing, A. S.

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Dow & Smith.
Howard, J. W.
Kirschbraun, Lester.
Van Trump, Isaac.

Traction Engines.
Austin-Western Road Machinery Co., The

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Trailers.
Warner Mfg. Co.

Trench Braces.
Kalamazoo Fdy. & Mach. Co.

Trench Machinery.
Holzbog & Bro., Geo. H.
Kalamazoo Fdy. & Machine Co.
Pawling and Harnischfeger.

Valves.
Coldwell-Wilcox Co.

Wall Coping.
Cannelton Sewer Pipe Co.

Warrenite.
Warren Bros. Co.

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American Cast Iron Pipe Co
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Waterproofing.
Barrett Co., The
Pioneer Asphalt Co.
Truscon Steel Co.

Water Purification.
Pennsylvania Salt Mfg. Co.

Water Works Supplies and Equipment.
American Cast Iron Pipe Co.
Alger Supply Co.
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Truscon Steel Co.

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Medal Paving Brick Co.
Murphysboro Paving Brick Co
Springfield Paving Brick Co.

Wood Block (Creosoted).
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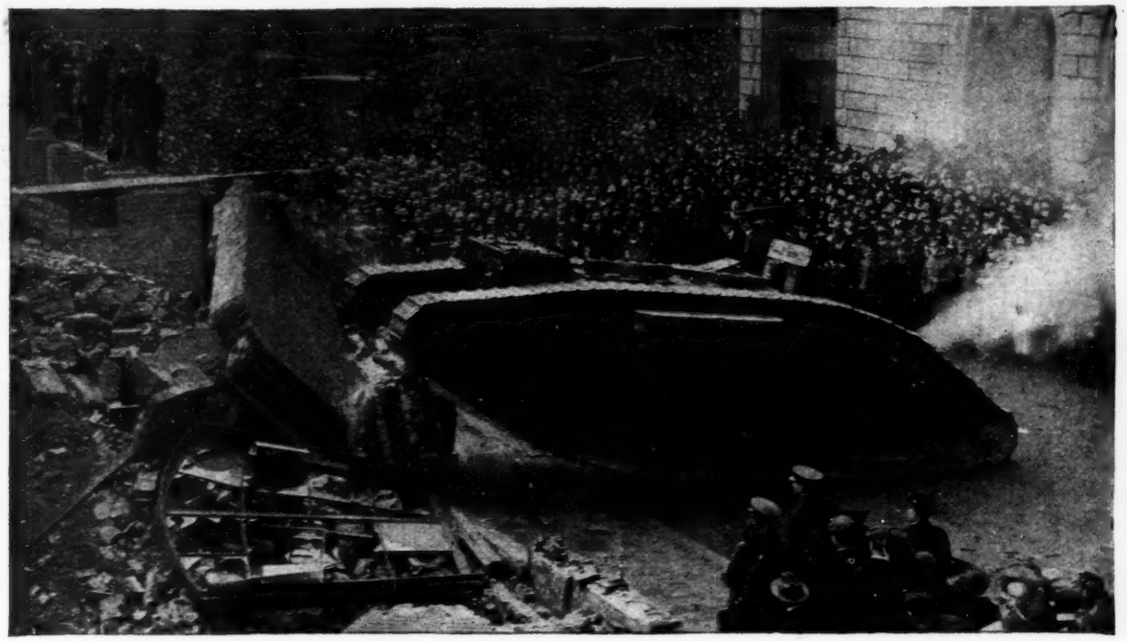
BITULITHIC stands the test of War Tank



(Photo by courtesy of ***Boston Herald***)

Veteran British War Tank "Britannia" on *Bitulithic Pavement* on
Trinity Place, Boston, Mass. (Trinity Place is "opposite Copley Plaza Hotel, Westminster Hotel and Trinity Church")
Demolishing old brick walls two feet thick of old Massachusetts Institute of Technology Laboratory Buildings.

THE "BRITANNIA," *weighing over 30 tons,*
traveled over the **Bitulithic** Pavements on
Dartmouth Street, laid on old macadam, 1903. Winter Street, laid on concrete base, 1913.
Trinity Place, laid on concrete base, 1914. Commonwealth Ave., laid on old macadam, 1916.
Without causing any damage to the pavement, notwithstanding

The "Tank" proceeding through crowd preparatory to demolishing the wall.

After demolishing the wall and proceeding of the "Tank" to other activities.

The extremely heavy weight and the cleats on the caterpillar belts.
The huge weight being supported by the inherent stability and great density of the **Bitulithic Surface Mixture.**

Warren Brothers Company

Executive Offices: BOSTON, MASS.

DISTRICT OFFICES:

NEW YORK, N. Y. ST. LOUIS, MO. PHOENIX, ARIZ. MONTREAL, P. Q. NASHVILLE, TENN.
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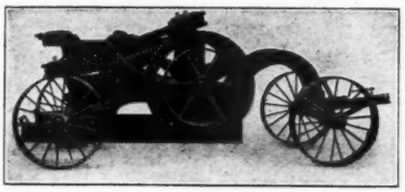
TORONTO, ONT. WINNIPEG, MAN. RICHMOND, VA. VANCOUVER, B. C.

They Stand the Test

Austin-Western Road Making Equipment has stood the test of the Great War. Our line of machinery has been used by the Allies on both east and west fronts since 1914.

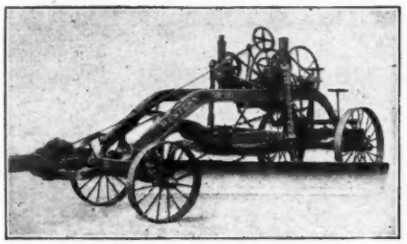


Western Crusher

Predicated on this severe service, as well as a world-wide reputation for almost 50 years, the words

AUSTIN and WESTERN

have become significant standards amongst road builders. Like the sterling mark on silver or Lloyd's certificate on a ship, "Austin" or "Western" on a road machine has a clearly defined value accepted by owners, users, purchasers and all concerned.

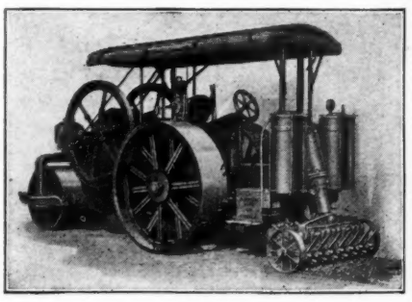


Western Grader

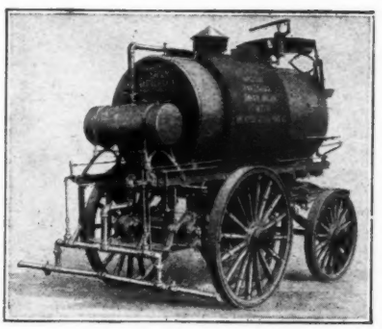
There are almost 250 sizes and styles of equipment in the **Austin-Western Line:**

Road Graders
Rock Crushers
Motor Tandem Rollers
Motor Macadam Rollers
Portable Stone Bins
Stone Elevators
Stone Screens
Elevating Graders
Blade Graders
Road Rollers
Road Scarifiers
Combined Scarifier Graders
Street Sprinklers
Street Sweepers
Combined Sprinkler-Sweepers
Dump Wagons
Stone Spreaders
Horse-Drawn Rollers

Catalogue No. 18 describes all of the above.



Austin Roller



Austin Oiler

Austin-Western Road Machinery Company — CHICAGO

BRANCH OFFICES: New York, Portland, Ore., Richmond, Va., Columbus, Ohio, San Francisco, Boston, Los Angeles, Memphis, St. Paul, Atlanta, Oklahoma City, Jackson, Miss., Dallas